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VERNACULAR NAMES OF SOUTH AMERICAN MAMMALS

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The following notes have a double purpose: to promote the standardization and systematization of non-technical names for South American mammals, and to identify the linguistic origin of such names already in use. Neither aim is here completely achieved and this communication is only a preliminary contribution to a relatively neglected subject that is both important and diverting as a zoological side-line.

The ideal of vernacular nomenclature would be to have a distinctive one-word name for each group of animals recognizable as of a distinct kind to an observant but untrained local inhabitant. In some groups, such as the cats, each well-defined species would have one vernacular name, while in others, such as many small rodents, one name would serve for a whole family or even for several families. From this nomenclature the scientific "common names" are usually developed by adding adjectival modifiers to the single-word vernacular names in order to distinguish regional subspecies and the like.

As far as the professional zoologist can exert an influence on the basic vernacular forms, it is to his interests to see that each does, in fact, apply to a unit that is scientifically valid. He should discourage definite misnomers like "Tasmanian wolf" and "spiny rat." Also in logic and as a general ideal, not always obtainable, it is desirable that if within any one group one unit has a single vernacular name, other units of comparable scope in the same group should also have such names. For instance it is illogical to distinguish pichiciego, cabassu, etc., but to call other members of the family simply armadillos.

Most common names for South American animals are derived from Indian languages. As far as an example will influence vernacular usage, it is a matter of integrity or scholarly pride to use names that are genuine, that really are or were applied to these particular animals by a considerable group of natives

in the area in question, and to favor forms of the names as near the original as is consistent with thorough assimilation into English. Such considerations should be compulsive *a priori*, but for names already in wide use, it would be mere pedantry to let them outweigh the advantages of usage and familiarity.

With a few exceptions, lexicographers have neglected words of American origin. It is true that the absence of old written literature usually prevents tracing much of the earlier history of Indian words or identification of the exact local dialect, but a borrowed word can almost always be traced to a specific linguistic family (of which there are more than eighty in South America) and usually to a particular language of that family. This is here done for most South American mammal names now in use or suggested for use in English.

The etymological study of vernacular names has also been relatively little noticed by mammalogists, in whose field this belongs as much as in the lexicographers'. The few published notes on South American mammal names have usually been sporadic comments and are seldom very reliable. Since the present paper was first written, what is, as far as I know, the first technical and well-grounded study devoted solely to indigenous mammal nomenclature in South America has been published, Dennler (1939, see references) on Guaraní mammal names. The parts of this paper affected by Dennler's excellent work have been rewritten.

The majority of Indian names for South American mammals used in the vernacular of European languages are from four native languages or groups of languages: Quechua, Araucanian, Carib, and Tupi-Guaraní. Quechua was the official language of the Inca Empire. Several names for Andine animals, like "llama," are derived from it. Araucanian was the language of most of Chile, the southern Andes, and in several dialects, of a considerable part of the Argentine pampas. A few names for Andine or southern animals, like "pudu" and "coypu," are from it. Carib designates a whole group of allied but quite distinct languages scattered over most of eastern South America and the West Indies, but especially on the eastern part of the continent north of the Amazon. It has, on the whole, had little effect on the English vernacular, but a profound effect on South American Spanish. A few familiar English names, like "peccary," do derive from it. Another group of languages that should be mentioned is the Arawak; no generally accepted English vernacular name seems to have come directly from it but a few Spanish vernacular names are of Arawak origin. The Arawak languages are spoken over about the same regions as the Carib. Tupi-Guaraní designates a family of languages spoken especially in Brazil south of the Amazon and in the region of Paraguay and Uruguay (the names of these countries being of Guaraní origin). It has two more or less standard forms, among a host of more local dialects. Guaraní, proper, was the speech of most of

Paraguay and some adjacent regions. With the coming of Paraguayan independence it became an official and highly cultivated language, perhaps to a greater extent than any other Indian language in post-Columbian times. In Brazil a form of Tupi there called "Lingoa geral" was more or less standardized, although even it has various minor dialects, and became the trade language for most of the Amazon basin. The great majority of vernacular South American mammal names of Indian origin are from some form of Tupi-Guaraní. This came about partly through the personal influence of men like Azara who knew Guaraní names and who were interested in mammalian nomenclature, but mainly because most of the novelties that flowed out from South America during the golden age of scientific discovery in the late 18th and early 19th centuries came from regions where Tupi, especially, and to some extent Guaraní were indispensable idioms for the collector. Carib names are also fairly common and came for the most part from the Guianas, especially from Cayenne whence several were obtained by Buffon.

XENARTHRA

Armadillos. This general name for all members of the group is of Spanish origin, although practically unknown among the Spanish-speaking peoples of South America. It is a diminutive of "armado," "armored." Most South American vernaculars have a separate name for each sort of armadillo distinguished, usually corresponding approximately to a genus. In English most armadillos are designated adjectivally, although for a few, like the cabassu and the pichiciego (more often but less correctly called "pichiciago"), special names are in use. The following are the most readily available special names now in use or appropriate for use:

Pichi = *Zaedyus*. This name (also spelled "piche" and "pichy") is already standard in Argentina. It is from the Araucanian and originally meant "little." Strictly speaking, the Araucanian name for this animal was *kumtrü*.

Pichiciego = *Chlamyphorus* and *Burmeisteria*. This word is also now vernacular in the Argentine and has already been generally adopted in English. It is in most English dictionaries in the incorrect, or at least less preferable, form "pichiciago." The word is Argentine Spanish *pichi*, "small armadillo" (from Araucanian, as above), plus *ciego*, "blind."

Apara = *Tolypeutes*. Recognized as a Tupi-Guaraní word, this was proposed by McMurtrie, 1831, as a generic designation. Like *pichi*, this word is not really the native name of the animal, but only an adjective describing it. The actual name is *tatú-apará*, or (Dennler, Guaraní) *tatú-pará*. In both Tupi and Guaraní all armadillos are called *tatú*. Tupi *apará* has been taken to mean "curling," but Dennler cites Guaraní *pará*, "spotted," as the etymology.

Peludo = *Euphractus* and *Chaetophractus*. The Argentines call these animals "peludos," a Spanish word meaning "hairy ones." There does not

seem to be any recorded Indian name now in European use or appropriate for use. Von Martius (1863) gives *tatu-peba* as a Tupi name probably applicable to some member of this group, but this may be an error. The name means "smooth armadillo" and is more likely to refer to *Dasypus*. In European usage the distinctive part of the name, "peba," is associated historically with *Dasypus* and not with the peludos. Dennler gives *tatú-podyú*, "yellow-handed [not -banded] armadillo," as Guaraní for *Euphractus sexcinctus*.

Tatuasu = *Priodontes*. I know of no European language vernacular name for this animal except "giant armadillo," a poor designation. *Tatú-asú* is Tupi and *tatú-guasú* Guaraní for "big armadillo," and may be a desirable designation in a simplified transcription such as "tatuasu." Many Caribs call the animal *mauraimá* (and variants), another possibility, but the animal's range is more in Tupi-Guaraní than in Carib country.

Cabassu = *Cabassous*. I believe this to be from some Carib dialect, not exactly identified, in which a form like *kabasu* occurred, cognate with *kapasi*, *kapasu*, *kapahi*, etc. of various modern dialects. The French form "cabassou" has already been used in English and "cabassu" seems better. Azara (1801) guessed that this name might be from Guaraní *caaigouazou*, "large forest-dweller," and this has generally been cited as its origin, but my derivation, if not demonstrably correct, is at least much more probable. The real Guaraní name of the animal is *tatú-at* (Dennler).

Peba = *Dasypus*. In the United States, where the animal is resident, this will doubtless always be called simply the "the armadillo," but where it contrasts with so many other sorts a special name is available. The Tupi name *tatu-peba*, "smooth armadillo," probably refers to this animal, although there is some confusion. In any case the name has gained some currency for these animals and has been applied to *D. novemcinctus* as a specific name (Desmarest, 1820). The Guaraní name is *tatú-hu*, "black armadillo" (Dennler). Another alternative is "cachicamo," widely used in the Spanish of northern South America and probably derived from the Carib of the Orinoco, although a more common Carib designation is *kaikán*. "Cachicamo" gained some currency in French, as "cachicame," and McMurtrie proposed *Cachicamus* as a subgenus, but the word is not familiar in English. All these names apply mainly or solely to *D. novemcinctus*. It seems unnecessary to me to have a different one-word designation for *D. hybridus*, but it could be called "mulita" (Spanish, "little mule" because of the ears), as it is in the Argentine. The Guaraní is *tatú-mbiricá* "long eared armadillo" (Dennler).

Tamandua = *Tamandua* (and in native usage also *Myrmecophaga*). This word is generally, and probably correctly, given as Tupi. In that language it refers to all anteaters (as *tatú* does to all armadillos), *Myrmecophaga* being *tamanduá-guasú*, "big anteater," and *Tamandua* (probably also *Cyclopes*) *tamanduá-i* or *tamanduá-mirín* (= *mbirín*), "little anteater." The word apparently does not occur in Guaraní in which *Tamandua* is *kaaguaré* (Denn-

ler), of doubtful etymology. This and the fact that forms of the word *tamandua* are common in Carib dialects suggest that it is really of Carib origin, borrowed in Tupi, but we doubtless have it from the Tupi. In Carib the word often means *Myrmecophaga* and not *Tamandua*. On native usage, it would be better either to call all anteaters "*tamanduas*," or to confine the name to *Myrmecophaga*, but English "tamandua" = *Tamandua* is so well established that it would be quixotic to suggest a change.

Jurumi = *Myrmecophaga*. It seems illogical to call *Tamandua* "tamandua" but to use only the descriptive "giant anteater" for *Myrmecophaga*. The Guaraní name best written "jurumi" in English (*yurumí, zhurumí, dyurumí* [Dennler], etc.) is explicit and has appeared in European literature (e.g. Brehm). It means "little mouth."

Ai = *Bradypus*. This is the Tupi name, already current in English. The duplicated form *ai-ai* also has native authority, but is an unnecessary complication and liable to confusion with "aye-aye" for *Daubentonia*. Dennler gives *aó-aó* in Guaraní.

Unau = *Choloepus*. This name was adopted by Buffon and is widely used in European languages, including English. It does not appear to be the usual Tupi or Lingoa geral name, which is *ai-mirim* (= *ai-mbirín*), "little sloth," but it does occur in some northern Tupi dialects, e.g. Oyampi, and is a genuine native name. (Dennler does not give any Guaraní name for *Choloepus*.)

LAGOMORPHA

Tapiti *ylvilagus* (*Tapeti*). This is also a Tupi-Guaraní word, variously transcribed as *tapití, tapetí, tepetí, tapotím, tipití*, etc., of which the first seems to be the best form. Gray's subgeneric name *Tapeti* is, of course, this word.

RODENTIA

Vernacular names for most of the distinctive hystricomorphs are listed below. No attempt is made to list names for myomorphs. In most cases the natives, like us, have a general word for "rat" or "mouse" and designate the kinds descriptively. Even when some distinctive name is used, it is usually impossible to tell exactly which cricetid it designates. It would be easy to select names for various squirrels, especially the *Sciurus aestuans* or *Guerlinguetus* group, but none is now in very common use and none seems necessary. There is no reason why all tree squirrels, such as occur in South America, should not simply be called "squirrels" and the sciuromorphs are therefore also omitted here.

The generic names are those recognized as valid by Tate (1935).

Cuandu = *Coendou*. This is a better phonetic transcription of the Tupi word *kwandú* used (in a French spelling) for the genus. The name has been used in European writings since 1658 and is sufficiently familiar even though

not now properly English vernacular. Perhaps *Chaetomys* should also be considered a cuandu. I find no special native name for it. The usual Guaraní form of the name for *Coendou* is *kuiy* (Dennler), often cited in French spelling as *couiy*, Azara's *cuiy*, but this is a confusing term not suitable for vernacular adoption because the Argentine "cui" or "cuys" is a caviid.

Paca = *Cuniculus* and *Stictomys*. This Tupi name is already in general use in English. There is little reason for vernacular distinction of the two genera except as mountain and lowland pacas. The original is usually cited as *pac* or *pak*, but *paka* is apparently also good Tupi. A Guaraní variant is *pai* (Azara) or *paih* (Dennler), alone or as *akuti-paih* (Dennler). The word "lapa," used in northern South American Spanish, and in Guiana English as "labba," is the Arawak name.

Aguti = *Dasyprocta*. This universally used vernacular name, the spelling of which as "aguti" seems preferable to "agouti," "agouty," etc., is also of Tupi-Guaraní origin and has many variants in that group of languages and neighboring dialects, *akuti*, *aguti*, *akuchi*, *akushi*, *agushi*, *kotia* (or *cotia*), *kotinya*, *kutia*, *akuri*, *akure*, etc. All of these are radically the same name, but apparent differences in application may arise from the localization of certain types of agutis and of certain dialect variants of the word. If *Cutia* Liais is anagram of *acuti*, as Palmer (1904) says, it is curious that it is also a valid Indian variant of the same word.

The Venezuelan name "acure" is the same word, transmitted through a Carib dialect of northern Venezuela. According to Dennler, in Guaraní, *akutí* is a family term for all pacas and agutis, but this apparently is not true in Tupi and certainly is not true in various Carib dialects that use cognates of *akutí* (usually in the form *akurí*) for the agutis only and apply a different word, sometimes the Tupi *pak* but usually the true Carib *uraná*, to the pacas.

Acushi = *Myoprocta*. This name is fairly well established and will perhaps continue as standard for the species of *Myoprocta*. If it is to be used, the spelling acushi is preferable to acouchy which is a French form inevitably mispronounced in English. As a personal preference, I would suppress the name acushi and call the species of *Myoprocta* "tailed agutis." Acushi is, in fact, the same word as aguti. No zoological distinction is involved in the Indian originals. It merely happens that the form "aguti" was picked up direct from the Tupi in Brazil and "acushi" from the Carib language proper to French Guiana, where it had been borrowed from the Tupi.

Cavy = *Cavia*, *Galea*, *Caviella*, *Monticavia*, *Nanocavia*, and *Kerodon*. This name is already in common colloquial use and few will dispute that it should be universally used in place of the ridiculously inept "guinea pig," so-called, as someone has remarked, because it does not come from Guinea and is not a pig. It should also be confined to members of the genera listed here and not, as has occasionally been done, extended with adjectival modification

to include such disparate animals as *Dolichotis* and *Hydrochoerus*. Although the retention of the word "Cavy" is to be strongly recommended, it is perhaps based on an error. The real, or at least the common Tupi word is *savia*, but linguistic authorities also spell this *çavia*, whence *cavia*=*kavia* has been written probably in error. Erxleben (in Treviranus) even emended the generic name to *Savia*. This is a confusing point also involved in names of deer. Dennler has supposed that the opposite occurs also (or instead), that *k* was written *c* then erroneously *ç*=*s*. Probably these are really diaphones in Tupi-Guaraní, that is, *k* in one dialect may be pronounced *s* in another. In that case there may really be an Indian word *kavia*=*cavia* but I have no good authority for this. The same and perhaps another error may be involved in the French "cobaye," which is possibly from Tupi *sabuya*=*savia*. Cobaye also appears to be confused with *çobaya* or *sobaya*, which means "animal with a tail," and is probably the most inappropriate name possible except "guinea pig." There does not appear to be any native name *cobaya*=*kobaya*.

"Aperea" is sometimes used for one or more wild members of the genus *Cavia s. s.* It is a form of the Tupi-Guaraní *aperea*, *prea*, *preya*, etc., adopted in Brazilian Portuguese and hence occasionally in English and other languages. I see no reason for its use, nor for giving special vernacular names to the finely split and, to the lay eye, barely different allied genera *Caviella*, *Monticavia*, etc. The word "moco," also Tupi-Guaraní, has been used especially for *Kerodon*; but some members of *Cavia* and of *Galea* have been called "mocos" and the name is both ambiguous and unnecessary.

Capybara=*Hydrochoerus*. There can be no doubt about the use of this excellent vernacular name, again of Tupi-Guaraní origin. "Capivara" would more nearly represent the Tupi form, but "capybara" is now standardized. As usually happens, the native etymology is disputed and not to be taken very seriously. Most agree that the first two syllables are from *kaapi* (or *capi*), "grass," but different students suppose the last two to be from *uara* (=*wara* or *vara*), "lord," *goara* (perhaps also =*wara*), "dweller," or *guara* (possibly also =*wara*), "eater." Dennler gives a Guaraní form *kapiihva* and omits discussion of the etymology. The usual South American Spanish names are "carpincho" (Argentina) and "chigüire" (Venezuela), words of doubtful but probably Indian origin.

Mara=*Dolichotis*. "Mara," the Araucanian Indian name, is occasionally used for this animal and was proposed by d'Orbigny, 1829, as a technical name for the genus. Its vernacular use is recommended because the usual name "Patagonian hare" is bad and the alternative "Patagonian cavy" is not much better (especially as there are real Patagonian cavies quite distinct from this animal). The name really native to Patagonia (the Patagonian, Tehuelche, or Tsoneca language) is *bakur* or *paahi*, but the Araucanians also have the animal and their name is more familiar and more euphonious.

Chinchilla=*Chinchilla*. The origin of this name has given rise to speculation supported by almost no facts and is really unknown, as far as I can determine. The name appears to be an old Spanish diminutive of a word "chincha," a probability supported by the fact that this or allied animals (e.g. *Lagidium*) are sometimes called "chincha" in South American Spanish. "Chincha" is generally said to be a "native" or "Indian name," but its original form and language seem never to have been identified. The word "chinchilla" does appear in one vocabulary as Aimará (or Colla, a Peruvian language), but it is probable that it is there borrowed from Spanish and not the reverse. Some etymologists relate the word to "chinche," "bug," but this cannot be taken seriously. There is a town "Chinchilla" in Spain, which again seems to have nothing to do with the case.

Viscacha=*Lagidium* and *Lagostomus*. This well-known word is taken from Quechua with little change. The two genera are best distinguished as mountain and plains viscachas, respectively, rather than by separate names.

Coypu=*Myocastor*. "Coypu" has been widely used both in technical and in vernacular language and can be found in most English dictionaries. It is a northern Araucanian (Mapuche) word. "Nutria" is ineradicable in the fur trade, but there is no reason for using so ambiguous a name in the scientific vernacular. It is a Spanish word that originally meant "otter," and still does, but was extended in South America to include the coypu by settlers who did not distinguish the animal from the otters. Now when the animals are distinguished in South American Spanish, "nutria" is usually confined to the coypu and the real "nutrias," i.e. the otters, are called "lobo de agua" or "perro de agua," "water-wolf" or "water-dog." Dennler has commented on the confusion created by this shift of terms. He gives *kihdyá* (=*kiyá*, *kijá*, or *quiyá*) as the Guaraní name, but "coypu" is unambiguous and no other vernacular name is needed.

Degu=*Octodon*, *Octodontomys*, *Spalacopus*, *Aconaemys*, *Octomys*, and perhaps *Abrocoma*. This name is from the Araucanian *dewü*. It reached its present poorly phonetic form in passing through Chilean Spanish. It is not in universal use in English, but has occasionally appeared in that and other European languages and is a convenient name for the rodents of this peculiar group.

Tucotuco=*Ctenomys*. This name, also spelled "tucutucu," "tucotucu," etc., is a good imitation of the sound ceaselessly made by the animal. As such it is an obvious onomatopoeic name. Words like it occur in various Indian languages, but we have it from Spanish (probably from the Argentine). I cannot determine whether the Spanish was from an Indian language or, if so, from what one. The Guaranís had a similar imitative word but also used a descriptive name, *anguyá-ibigüí* (Azara) or *angudyá-ihvihgwih* (Dennler), "subterranean mouse."

Urare = Echimyidae (as used by Tate, 15 genera). Considering their great abundance, wide distribution, and peculiar character it is curious that few vernacular names have been used for these animals. I have not noticed any English reference that calls them anything but "spiny rats," inappropriate for animals that are hystricomorphs and not myomorphs. Some German authors (e.g. Brehm) follow Snethlage who said that they are called "sania" at Para. I do not find this word in the usual vocabularies, but it may be from or related to Tupi *sanie, sanye* (*çañe, çanhe*), "rapid, hurry." Recorded Tupi names are *sanguja*, which is applied also to true myomorphs and is correctly translated simply as "rat," *guabyru-ju*, which means "spiny rat," and *aguti-puru*, which appears to mean "the borrowing aguti." I can vouch at first-hand for a central Carib word *urare* referring to this animal. In a Makuchi vocabulary gathered at Manaos by Georg Hübner and published by Koch-Grünberg (1908) *urare* is said to mean "*Hesperomys*," but this is either a peculiar local usage or an error because I have fixed the word exactly by confronting central Caribs with actual specimens of these animals.

PRIMATES

Technical nomenclature of the South American primates is much debated and confused. The following are the names that I believe to be valid under the rules and they apply to units that I would give generic rank. Perhaps no one else would recognize exactly these genera, but most will agree that they are natural units. The vernacular nomenclature has also been inconsistent and an attempt is made to systematize it.

Douroucouli = *Aotes*. This word is said to come from the upper Orinoco but it is not clear whether it is Tupi in origin. It is probably a French spelling of an Indian word something like *durukuli*. "Cusicusi" is another name of doubtfully Tupi origin. "Miriquina," a name sometimes used in Spanish, is presumably from the Guaraní *kaaí-mbirikiná*, "small companion forest-dweller" (Dennler). In Guaraní most monkeys of medium size are called *kaaí*, "forest-dweller," and the kinds (genera for the most part) are distinguished by adjectival suffixes.

Titi = *Callicebus*. This is a Guaraní name, but there is no native precedent for confining it to this genus. In Guarani *Aotes, Ateles, Cebus, Saimiri*, and perhaps some others are called *kaaí*, while *Callicebus, Callithrix, Leontocebus*, and probably several other genera are called *titi*. The use of "titi" in the English vernacular is also inconsistent, but most of the so-called titis belong to *Callicebus*. It would be well to make the vernacular and generic names coextensive.

Uakari = *Cacajao*. This name is Tupi, already generally understood as designating this genus in English and other European languages.

Saki = *Pithecia* and *Chiropotes*. This name has been adopted in various European languages, following Buffon (vol. 15, 1767). Like several other

such names, its native origin is uncertain and its European applications inconsistent. It is probably from a Tupi word *sagi* (g hard), which includes several small monkeys mostly referable to *Saimiri* and *Callithrix*. There is, however, a tendency in English to confine "saki" to *Pithecia* and *Chiropotes* and there is no reason why usage should not be fixed in that sense.

Aluata=*Alouatta*. These are the "howling monkeys" or "howlers" of the present vernacular. It is more in keeping with the accepted nomenclature of South American monkeys to give the genus a non-adjectival name. "Aluata" is for us a more phonetic spelling than the French form "alouatta" of the Carib name. *Aluata* is a genuine Indian word, although *arauta* or *arawata* are more common. The last has given the Spanish vernacular "*araguato*." The Tupi-Guaraní name *carayá* (or variants) is also sometimes used in Spanish. Cabrera (1939) is mistaken in thinking that *Alouatta* is from a Central American name of these animals. There is no serious doubt that it is from the Carib of Cayenne. It is sometimes supposed that "aluata" is proper for *A. senicula* and "caraya" for *A. caraya*. This is caused only by coincidental geographic distribution of languages and animals. A Carib would certainly call *A. caraya* "aluata" ("arauta," etc.) and a Guaraní would call *A. senicula* "caraya."

Capuchin=*Cebus*. This thoroughly established name is that of the religious order, long applied to these monkeys because of the fancied resemblance of their hair to a Capuchin cowl. This abundant, varied group naturally has a great many local and specific native names, some of which have been used in European languages, but it would seem preferable to use "capuchin" in the generic sense and designate local forms adjectivally. Among the names occasionally mentioned in the literature are the Tupi-Guaraní *sai* or *cai*, *caitaia*, and *caiarara*, Carib *miko* and *ibarga* (both with many variants), Arawak *fudi*, *pudi*, Quechua *kusillu*, *yuramachi*, etc.

Saimiri=*Saimiri*. I see no reason why this name should not be used in vernacular as well as in technical form. Other available names are cumbersome, ambiguous, or obscure designations of local forms. The name is based on Tupi *sai-mirim* (or *çai-mbirin*), *sai* being a name used for many monkeys and *mirim* meaning "small." According to Dennler the Guaraní is *kaaimbiri* and the derived European vernacular should be "caimiri." He states that "çaimiri" was written in error for "caimiri." Unless, however, most vocabularies are wrong, "çaimiri" (="saimiri") is a genuine Tupi, if not Guaraní, dialect form. He ascribes the error to Buffon, but it also occurs in vocabularies certainly gathered from the Indians and not from Buffon. Dennler may have overlooked the possibility that the word he heard only as *kaai* is really pronounced *sai* by other Indians. Many of these names, probably most of them, were brought to scientific notice through Tupi rather than through Guaraní. The two languages are very similar, but they are not the same.

Coaita=*Ateles*. Various forms of "coaita" have been used in the literature (e.g. by Bates, 1863, among many others) and this name seems preferable to the more usual "spider monkey." *Koaitá* is a Tupi dialect form cognate with one (or both) of the Guaraní words given by Dennler as *kaaí-tá*, "hairy monkey," and *kaaí-taá*, "spider (?) monkey."

Miriki=*Brachyteles*. If this genus is to be distinguished from *Ateles* in the vernacular, this Tupi name is available. Otherwise it might simply be called "woolly coaita."

Maricamico=*Lagothrix*. These monkeys are called "barrigudo" ("big-bellied") in Brazilian Portuguese and the name has sometimes been used in English vernacular, but the Tupi (upper Amazon) equivalent, although long, seems preferable. *Maricamico* also means "belly monkey" in Tupi (*mico* is borrowed from Carib).

Callimico=*Callimico*. This is a bastard name derived from Greek *kalos* and Carib (or Tupi from Carib) *miko*. The callimicos are usually but ambiguously called "marmosets."

Marmoset=*Callithrix* (=*Hapale*, *Jacchus*, not *Callicebus*). "Marmoset," from French "marmouset," "manikin," is well established as referring principally to this genus. Variants of the Tupi name *oyapusa* also occur in the literature. There is considerable confusion as to whether Tupi *sau* (*sahu*, *sahua*, etc.) and Guaraní *titi* refer to this genus or to *Callicebus*, and it is probable that they are applied to members of both. In any case "titi" now applies mainly to *Callicebus* in our vernacular. Dennler gives Guaraní *titi-tí* for *Callithrix jacchus* and supposes Buffon's "vistiti" to be an erroneous form of this name.

Tamarin=*Leontocebus*. Like "marmoset," this name has been generally adopted from the French, but the origin of the French word is obscure. It was popularized by Buffon (vol. 15, 1867), who believed it to be an Indian word from Cayenne and the Marañón—two regions that have no native languages in common. Buffon's information came from the travelers Biret and d'Abbeville. I find no probable source for the word in any of the vocabularies collected by students of linguistics. The word may somehow have been garbled in transcription and perhaps shows phonetic assimilation to the totally distinct French word "tamarin" for the tamarind, a plant. Carib names for the animal are *kusiri*, *kushiri*, Arawak *silile*, *sirire*, Guaraní *titi-pitá*, all with other variants.

CARNIVORA

Maikong=*Dusicyon* (*Cerdocyon*). Osgood (1934) is followed in the vexatious technical nomenclature of the canids. The members of this subgenus are usually called foxes, but they are no more foxes than they are dogs or wolves or jackals, and it is preferable to give them a distinctive vernacular name. "Maikong," already occasionally used (e.g. in Brehm) is the most

widespread Carib name for them, in a spelling reasonably good for a rough approximation of the Indian pronunciation. In reading the older literature it should be remembered that authors have referred to "*Canis azarae*" animals belonging to at least three radically different groups. Indian names so defined in vocabularies are generally of unknown real meaning.

Culpeo = *Dusicyon* (*Dusicyon*). This subgenus as defined by Osgood includes most of the so-called South American foxes, especially the "gray foxes" = gray culpeos, and the "red foxes" = red culpeos of Argentina and adjacent countries. The Araucanian name "culpeo," already somewhat popularized in the Argentine, is appropriate for the group. The "aguarachai" of Azara, a Guaraní name, probably also refers to these animals.

Guara = *Chrysocyon*. The Tupi-Guarani name *guara*, which has been applied to this animal and may well be more widely used, undoubtedly includes it, although perhaps not exclusively since it seems only to be a form of *aguará* and *jaguará*, meaning canids in general. The most specific name is the Guaraní *aguará-asú*, *aguará-guazú*, etc., meaning "big dog," but for our vernacular purposes "guara" is less clumsy.

Bush dog = *Icticyon*. I find no satisfactory substitute for this poor but universal vernacular name. The only Indian word that I know beyond question to refer to this animal is from a single rather obscure dialect (Kamarakoto) at the edge of the area occupied by *Icticyon*. It is impossible even to approximate this word in English phonetics.

Coati = *Nasua*. This word appears with many variations in Carib, Arawak, and other languages but is apparently of Tupi-Guaraní origin and has entered our language indirectly from that source. *Coatimundi* is also good Tupi, but the complication is unnecessary. The broad use of "coati," a shorter and more general term, seems preferable in English.

South American raccoon = *Procyon cancrivorus*. This is the "crab-dog" of Guiana, a remarkably inept designation. Both Caribs and Arawaks near the coast have now adopted this English name in the peculiar form *krabudago*. I do not know any real Carib or Arawak name for the animal, although it seems that they must have one. Tupi-Guaraní names are *aguará*, *agoará*, *agoará-popé*. "Aguara" has been used as a vernacular name, but it is not satisfactory, in the first place because it means in Tupi not only this *Procyon* but also one or all of a variety of canids and in the second place because it is on this account liable to confusion with several other cognate or partly cognate Tupi-Guaraní words that are used in the vernacular, such as *guara*, *jaguar*, etc. The word "raccoon" is North American.

Kinkajou = *Potos*. The Century Dictionary says that "kinkajou" is a form of the French-Canadian word "carcajou" and that this, in turn, is from the Montagnais Indian. I have searched for a trace of such a word in some fifty South American Indian languages and failed to find anything like it.

Taira = *Galera*. This generally adopted name is usually designated as

Tupi, but the common Tupi name is *irará*, which has also been used as a vernacular name by Europeans, sometimes as "hyrara" or "hyrare." Dennler gives a Guaraní form *eirá*, which could well be cognate with *irará*, and in at least one Carib language (Kaliña) the animal is called *airá*. The word in some dialect form like *eira* or *aira* is probably the origin of the European "tayra" or "taira," which dates at least from Oken. Whether the *t* is from an Indian variant unknown (to me) or was adventitiously introduced in the Europeanizing does not appear.

Grison=*Grison*. This likewise generally adopted name is French and refers to the hoary appearance of the animal.

Skunk=*Conepatus*. There seems to be no reason for adopting a separate English name for the South American species. There are a host of Indian names, and it is unfortunate that one of them was not adopted in Spanish, in which language there is no good name for skunk ("zorrino" and "zorrilla" being inappropriate and misleading). Our word is of North American Indian origin and its etymology is outside the scope of these notes.

Saro=*Pteronura*. I am not convinced that these animals need a more explicit name than "South American otters," but if one is desired the name "saro" is available. Already mentioned by several travelers (who do not always correctly identify it), it is the name used in most Carib dialects. Here again the South American Spanish nomenclature is ambiguous (see "coypu" on a previous page) and use of the Indian word would be desirable. An alternative but less euphonious name is the Guaraní *ariraí* (Dennler).

Puma=*Felis concolor*. Our word "puma" is derived from the Quechau language. Most South Americans, like us, call these cats "lions" ("leones"), but it is generally agreed that "pumas" is the best name for them.

Jaguar=*Panthera onca*. This name is Tupi-Guaraní, in the dialects of which *jaguar*, *jaguara*, *dyaguá*, etc. mean not only this big cat but also various other cats and even dogs, a peculiar confusion frequent in South American Indian languages.

Ocelot=*Felis pardalis*. Our name "ocelot" is from the Aztec (Nahuatl) *ocelotl*, a name that seems to have included the jaguar. Some purists and travelers in Brazil to whom the Mexican name was relatively unfamiliar have used variants of the Tupi-Guaraní *mbarakaya*, which in various dialects and borrowed forms becomes *brakaya*, *marakaya*, *margaya*, *marakada*, etc. These names include the ocelot and in some cases refer primarily to it, but they usually also include smaller wild felids, but not the jaguar.

Margay=*Felis tigrina*. This widely accepted name, which is better pronounced "mar-guy'" than "mar'-gay" as it is marked in many English dictionaries, is a form of the word *mbarakaya* (Guaraní), which means the ocelot but also the smaller wild felids of this region. "Margay" in this sense may be derived more directly from Tupi *marakay-i*, "little ocelot," "small cat." In any case it is standardized as "margay" now.

Jaguarundi = *Felis yaguarundi*. This name is also Tupi-Guaraní. The spelling "jaguarundi" is already used in English and is preferable to the likewise used "yaguarundi." The root is the same as that of "jaguar."

Eira = *Felis eyra*. This word is of Guaraní origin and is the same as the Guaraní word for *Galera*, and hence probably related to, or identical with the origin of our word "taira," a confusing transfer. The Guaranís call the animal *eirá* in ellipsis for *mbarakadyá-eirá* (*marakay-eirá*), i.e. "taira-cat," presumably from a fancied resemblance to the taira (Dennler). The various Indians do not appear usually to make the equivocal distinction between jaguarundis and eiras. They usually also include *F. wiedi* as a *marakaya* (or variant) and I do not know any good vernacular name for that species.

Kodkod = *Felis pajeros*. This, the Araucanian name, is proposed for the "pampa cat," a name objectionable on two counts: Because it is by no means the only cat of the pampas and because it is no nearer to the cat, strictly speaking, than are the ocelot, jaguarundi, or many others that are universally given distinctive names. In Araucanian the two *o*'s of *kodkod* are both long and the *d*'s soft, resembling *th* in "that," but "code-code" would be an acceptable English pronunciation.

SIRENIA

Manatee = *Trichechus*. This name is usually said to be of Carib origin and this is probably correct. It is, however, curious that no recently recorded Carib language or dialect seems to have a name for this animal that even remotely resembles *manatí*. In both the Carib and the Arawak groups of languages the manatee is usually called by variants of a word *kuyumuru*, *koyumolu*, *koimuru*, etc. There is, however, a genuine and indubitable Carib word *manatí*, with numerous but slight variants, that means "(a woman's) breast." It is also true that the character of the sirenians that has most struck observers, and particularly primitive peoples, all over the world is that their mammae are extraordinarily like those of humans and unlike those of almost all other mammals. On this indirect but impelling evidence, I believe that this is the real origin of the name. It is not known and probably is not now determinable whether the island Caribs actually applied some form of this word to the manatee as its name or whether it was used only descriptively by them and mistaken for a name by the early European visitors. It is clear that the Spanish colonists in the West Indies did accept "manati" as the name for the animal and that we took "manatee" from them.

ARTIODACTYLA

Peccary = *Tayassu* spp. Both scientific names of *Tayassu tajacu* are variants of the Tupi-Guaraní name for these animals. Our vernacular name is from a widespread Carib root, evidently through a Guiana dialect in which forms like *pakirá* occur. Through a northern Venezuelan dialect, the same

word has given rise to the colloquial Spanish "báquiro." The Caribs usually apply this name to the collared peccary and have a different name for the white-lipped peccary, although "báquiro" in Spanish is applied to the white-lipped, not to the collared, peccary. *Patira*, which has also been used as a scientific name, is another variant of the Carib word, = *pakirá*.

Alpaca, Guanaco, Llama, Vicuña = *Lama* spp. The four universally accepted names of the South American camels are all from the Quechua language. The original of "alpaca" seems to be *paco*, and *al-* may be an accidentally incorporated Spanish article ("alpaca" from "el paco," compare "alligator" from "el lagarto"). The word is commonly written "alpaca" in that language, as in English but "paco" and "paca" are also used. The *g* in "guanaco" should be silent (the word is *wanáko*). The other names substantially represent the originals. The occasional spelling *glama* is an ill-advised attempt to represent the same sound as *ll*, a palatalized or mouillé *l*. This sound is difficult for the English tongue at the beginning of a word and there is no reason why it should be attempted, "lama" being a proper English pronunciation of "llama." There is still less reason for imitating the colloquial Spanish pronunciations "yama" and "zhama."

Cariacu = *Mazama* spp. *Kariaku* (*cariacu*), *kariyauku*, etc. are Carib names for *Mazama nemorivaga*. The name has been mentioned in the literature, but without any clear definition. Lesson, 1842, named a subgenus *Cariacus*, based on this name but not on the animals really so called by the Indians and essentially a synonym of *Odocoileus*. (Species of *Odocoileus* are not called *cariacu* by the Indians). Although the Caribs use a different name (*kusari*) for the red species of *Mazama*, it is permissible in another vernacular to extend the name of one to both (as was done with "peccary," for instance) and to call the two groups gray and red cariacus. The name "brocket" has been applied to them, but seems to me objectionably ambiguous, and indeed a name for these deer is much needed, even if the other South American deer be designated only adjectivally. Gray's name *Coassus*, for *Mazama*, is based on a poor spelling of the Tupi word for deer in general and should not be basis for a vernacular name.

The word "mazama," itself, is from Hernandez's rendering of a Mexican name, presumably a distortion or variant of the Nahuatl word *mazatl*, "deer." A study of Mexican mammal names is needed and would be very interesting. As a vernacular name "mazama" cannot correctly refer to members of the genus *Mazama*, which does not range into the Nahuatl area.

Waiking = *Odocoileus gymnotis* and close allies. This spelling (with *ai* as in "aisle") closely represents a common native pronunciation of the Carib name for the South American forms of *Odocoileus*. If native names are to be used for South American deer, this seems the best available for these animals, otherwise known as "savannah deer."

Huemul = *Hippocamelus*. The vernacular name of this animal is Arau-

canian and should be pronounced "way-mool.'" It has been spelled in a dozen ways, *guemul*, *huemul*, *huamul*, *guamul*, *hu.mel*, etc. but "huemul" is perhaps as little misleading as any.

Guasuti = "*Ozotoceras*" *bezoarticus*. This is the "pampas deer," the correct generic name of which is uncertain. It is commonly called by a single native name in South America and this may be desirable. "Guazuy," is now sometimes used, but "guasuti" has also appeared in print and is probably a better form of the word. As in English, so in Tupi-Guaraní there is one word for "deer," *suasú* in Tupi and *guasú* or *gwasú* (Dennler) in Guaraní. (This is probably correct and "cuasu," etc., an error for "çuasu" as far as Tupi is concerned, but here again is found the confusion between $k=c$ and $ç=s$, previously mentioned). "Guazuy," sometimes interpreted "little deer," is perhaps a contraction or poor spelling of *guasu-tí*, "white deer." The Tupi equivalent is *suasú-tingá*, also meaning "white deer" and also sometimes used in other vernaculars.

Guasupucu = "*Blastocerus*" *dichotomus*. If a single vernacular name is desired for the "marsh deer" "guasupucu" is probably best. It is Guaraní *gwasú-pukú* (Dennler), "long (i.e. large) deer." The Tupi is *suasú-pukú*.

Pudu = *Pudu*. This generally accepted vernacular and scientific name is from the Araucanian *pŭdu*.

PERISSODACTYLA

Tapir = *Tapirus* (*sens. lat.*). Although also used for the Asiatic tapir, this name is another of Tupi origin. *Tapira*, *tapii*, etc. in those languages designates animals in general and the tapir in particular. Similarly our word "deer," originally meant animals in general (German "Tier"). When cattle were introduced in Brazil they were called "foreign tapirs" in Lingoa geral, *tapira-sobaigoara* (*sobai*, "island, land across the water," *goara*, "dweller"), and sometimes also simply *tapira*. Although not especially apropos here it is curious that the name "anta" or "danta," which most South Americans of European speech apply to the tapir, is said to be not of American but of African origin. Dennler gives the Guaraní word as *mborevi*, as did Azara, although other authorities give a variant of *tapira* also in that language.

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At least a hundred publications, zoological and linguistic, were consulted in the preparation of this paper. Of the former, only a few directly cited in the text are listed here. Citations of authority have not been given for each Indian word separately, except for those quoted from Dennler, 1939. Almost all will be found in the several convenient compilations and standard linguistic works listed here, which also contain references to much of the detailed and special literature. Some of the remarks on Carib names, particularly, are based on personal knowledge, but most of the others are derived from the literature.

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FOOD HABITS OF CHIPMUNKS

By Shaler E. Aldous

In September, 1938, the writer began a study of the habitats of small rodents in northern Minnesota, in order to learn something of the distribution of these animals in the various forest types as a preliminary to a more specific study of their relationship to forest reproduction. During the study 987 specimens were trapped and preserved. Among these were 40 chipmunks (*Eutamias minimus jacksoni*), of which 34 of the stomachs and 12 of the cheek pouches contained food. In 1939, 26 stomachs and 13 cheek pouches of chipmunks taken during August, and 11 stomachs and 5 cheek pouches of animals taken during September brought the total with the previous collection up to 71 stomachs and 30 cheek pouches. The findings from these collections and from field observations are the basis for this discussion.

The habitat of chipmunks has an important bearing on the kinds and quantity of foods eaten. The food habits of these animals, like those of many others, are influenced very largely by availability. Chipmunks collected in September, 1938, were from a number of different forest types, whereas those taken in August and September of 1939 were almost wholly from jack pine-aspen-birch and black spruce associations.

In most cases volumetric appraisal was impossible, because the food was finely chewed. The quantity of the various items and the frequency of their occurrence are, therefore, the criteria used in presenting the results.

ANIMAL FOOD

Although it is generally known that chipmunks eat animal food, the extent of its consumption is only vaguely realized. References to the taking of animal matter by chipmunks of the genus *Tamias* are quite common but those for *Eutamias* are both rare and brief. Bailey (1931 and 1936) referred to the consumption of insects and other small animals by *Eutamias* on several occasions, especially of grasshoppers and caterpillars captured on sage brush. Grinnell (1908) refers to the destruction of wood pewee eggs by *Eutamias*. Baysinger (1940) discusses the eating of white fir aphids by this genus of chipmunks and Twining (1940) intimates that they are one of the chief enemies of the Sierra Nevada rosy finch.

In the present study examination of the cheek pouches showed no animal food, indicating that items of this nature when taken are eaten at once and not stored for future use. Of the August and September stomachs, 81 and 80 percent, respectively, held animal food, which varied from a trace to 100 percent of the contents.

Orthoptera occurred in 30 percent of the stomachs, and so received top rating among animal foods. The remains found consisted almost exclusively

TABLE 1.—*Food items eaten by chipmunks (Eutamias m. jacksoni) during August and September in northeastern Minnesota. Percentages are based on the contents of 71 stomachs and 30 cheek pouches*

ITEM	STOMACHS						CHEEK POUCHES					
	August occurrence		September occurrence		Total or average occurrence		August occurrence		September occurrence		Total or average occurrence	
	No.	*Pct.*	*No.*	*Pct.*	*No.*	*Pct.*	*No.*	*Pct.*	*No.*	*Pct.*	*No.*	*Pct.*
Vegetable	26	100	38	84	64	90	13	100	17	100	30	100
Abies	—	—	1	2	1	1	—	—	—	—	—	—
Aquilegia	—	—	1	1	1	1	—	—	1	6	1	3
Aralia	—	—	—	—	—	—	—	—	1	6	1	3
Betula	—	—	2	4	2	3	—	—	—	—	—	—
Caltha	—	—	—	—	—	—	2	15	—	—	2	8
Carex	1	4	1	2	2	3	1	8	—	—	1	3
Chiogenes	7	27	9	20	16	23	—	—	—	—	—	—
Coptis	—	—	—	—	—	—	1	8	1	6	2	7
Cornus	—	—	1	2	1	1	—	—	1	6	1	3
Corydalis	4	15	2	4	6	8	—	—	1	6	1	3
Diervilla	1	4	4	9	5	7	—	—	1	6	1	3
Epilobium	—	—	—	—	—	—	—	—	1	6	1	3
Geranium	—	—	3	7	3	4	1	8	4	23	5	17
Glyceria	—	—	1	2	1	1	—	—	2	12	2	6
Gramineae	1	4	1	2	2	3	—	—	—	—	—	—
Labiatae	—	—	—	—	—	—	—	—	1	6	1	3
Maianthemum	—	—	—	—	—	—	—	—	1	6	1	3
Oryzopsis	—	—	—	—	—	—	—	—	1	6	1	3
Phleum	3	12	—	—	3	4	3	23	—	—	3	12
Physalis	—	—	1	2	1	1	—	—	2	12	1	6
Picea	—	—	1	2	1	1	—	—	—	—	—	—
Pinus	—	—	1	2	1	1	—	—	1	6	1	3
Polygonum	—	—	1	2	1	1	10	77	2	12	12	40
Prunus	—	—	—	—	—	—	—	—	1	6	1	3
Ribes	—	—	1	2	1	1	—	—	—	—	—	—
Rosa	—	—	—	—	—	—	1	8	—	—	1	3
Rubus	20	77	5	11	25	35	5	38	2	12	7	23
Vaccinium	19	73	13	29	32	44	1	8	3	18	4	13
Vicia	—	—	—	—	—	—	—	—	1	6	1	3
Unidentified	4	15	12	27	16	23	—	—	—	—	—	—
Animal	21	81	36	80	57	80	—	—	—	—	—	—
Arachnida	5	19	2	4	7	10	—	—	—	—	—	—
Birds	1	4	3	7	4	6	—	—	—	—	—	—
Coleoptera	10	38	8	18	18	25	—	—	—	—	—	—
Diptera	3	12	1	2	4	6	—	—	—	—	—	—
Hymenoptera	3	12	8	18	11	15	—	—	—	—	—	—
Lepidoptera	2	8	15	33	17	24	—	—	—	—	—	—
Orthoptera	7	27	14	31	21	30	—	—	—	—	—	—
Unidentified insects	5	19	2	4	7	10	—	—	—	—	—	—

of grasshopper eggs. One stomach contained 162 eggs and 7 others held 20 or more. Adult grasshoppers were found in only three cases.

Beetles (Coleoptera) ranked second, being found in the stomachs of 38 percent of the August and 18 percent of the September chipmunks. The quantities consumed, however, were very small. Both adults and larvae were eaten and the families Buprestidae, Elateridae, Curculionidae, and Chrysomelidae were represented.

Caterpillars or lepidopterous larvae ranked third, occurring in 24 percent of the stomachs. Most of them were found in the September series and consisted largely of a small species of Pyralididae. One stomach contained as many as 126 individuals of this family, and 8 stomachs contained 20 or more. Several other lepidopterous larvae were recognized, but they could not be identified because they had been so thoroughly masticated. On May 16, 1939, near Ely, Minn., a chipmunk was seen eating the pupa of a cecropia moth. The pupa was two-thirds eaten and inspection showed that it had been alive prior to the chipmunk's attack.

Hymenoptera were found in 15 percent of the stomachs and were represented by both ants and bees. The remains were always meager and fragmentary, hence specific identification was not attempted.

The remains of flies (Diptera) found in the stomachs included fragmentary parts of pupa cases and larvae, none of which were identified below the order. They occurred in only 6 percent of the total series, although they were present in 12 percent of the August stomachs.

Spiders, represented mainly by leg fragments of adults and by a few egg cases, were found in 19 percent of the August series but in only 4 percent of the September material, making the average frequency 10 percent.

The only vertebrate remains recognized were four occurrences of minute feather fragments from small passerine birds, plus two coincidental occurrences of small pieces of flesh.

VEGETABLE FOOD

The vegetable part of the chipmunks' diet was chiefly seeds and fruits although on two occasions leafy green material was found. Vegetation, which constituted 100 percent of the material from the cheek-pouches, occurred in 90 percent of the stomachs. In all, 28 genera of seeds were identified, some of them represented by 2 or more species.

Blueberries (*Vaccinum*), represented both by seeds and fruit pulp, were the most frequent item, being found in 44 percent of the stomachs. The greatest frequency of occurrence was during August, at the height of the blueberry season, when 73 percent of the chipmunks collected had been feeding on this fruit. One stomach held 320 seeds. The check pouches contained seeds of blueberries in 13 percent of the cases and in all instances the pouches were clean and completely free of all pulp or fruit stain. One

cheek pouch contained a cubic centimeter, approximately 3,700, of these seeds.

Raspberry and thimbleberry (*Rubus*) seeds rated second in frequency of occurrence in both stomachs and cheek pouches. Again the fruiting season played an important part in the quantities eaten. During August 77 percent of the animals had fed on raspberry (*R. idaeus*), and 38 percent had stored the seeds in their cheek pouches. The September specimens were taken from areas where raspberries were few and past their fruiting season, but where thimbleberries (*R. parviflorus*) were abundant and in full fruit. The latter species was represented only in the September series, being in 11 percent of the stomachs and in 12 percent of the cheek pouches. As many as 190 *Rubus* seeds were found in one stomach and 400 of the thoroughly cleaned seeds in one cheek pouch. Because the seeds were often extracted and placed in the cheek pouch it was necessary to identify the pulpy stomach contents by the characteristic styles from the berries. The partially eaten remains of raspberries commonly left on rocks and logs attested to the presence of chipmunks that had probably been frightened away before completing their meals.

Smartweed or bindweed (*Polygonum*) occurred in only one stomach but in 40 percent of the cheek pouches. Here again availability played an important part in the amount of this food taken. In the area near Ely, Minn., where the August specimens were taken, 77 percent of the cheek pouches contained seeds of *Polygonum cilinode*, whereas along the shore of Lake Superior in September only 12 percent of the specimens had gathered *Polygonum* and one of these occurrences was of another species. Seeds of these plants must form a very important part of the seed cache as in many places the outer hulls had been found removed, and it was a common sight to see the animals gathering the seeds from the twining stalks. One cheek pouch contained 86 smartweed seeds while 8 held quantities of 25 or more.

The creeping snowberry (*Chiogenes hispidula*) was an important food item during both months and was found in 23 percent of the stomachs. It was not found in any of the cheek pouches.

Timothy (*Phleum pratense*) was eaten in August but not in September, according to the food analyses. The stomachs contained only small amounts, usually hulls, but the cheek pouches held larger quantities. One yielded approximately 800 seeds and two others 44 and 55, respectively.

Wild geraniums or cranesbills were represented by 3 species, *Geranium columbinum*, *G. maculatum*, and *G. carolinianum*, occurring in 4 percent of the stomachs and in 17 percent of the cheek pouches. The number of seeds consumed was usually very low although 32 were taken from one cheek pouch.

Seeds of squirrel corn (*Corydalis*) were found in 15 percent of the August, and 4 percent of the September, stomachs. They were absent from the

August but were identified in 6 percent of the September cheek pouches. The fragile nature of the seed coats made it necessary to identify these seeds in the stomachs by very minute fragments of their characteristic outer covering.

Seeds of the bush-honeysuckle (*Diervilla lonicera*) were recognized in 7 percent of the stomachs and in 3 percent of the cheek pouches. This plant is quite abundant. Its seeds ripen during the forepart of September, when it was much more frequent among the foods than in August.

The trees whose seeds were identified in these analyses were birch (*Betula*), in two stomachs; black spruce (*Picea mariana*) and balsam fir (*Abies balsamea*), each in one, and jack pine (*Pinus banksiana*), in one stomach and one cheek pouch of different individuals.

Red-osier dogwood (*Cornus stolonifera*) was found in only one stomach and one cheek pouch, but in each case it made up 100 percent of the contents. The stomach contained pulp and skin of the fruit whereas the cheek pouch held only stony pits to the number of 66. The two occurrences represented different animals. The presence of the pits in the cheek pouches of a chipmunk and the absence of the fleshy part of the fruit from its stomach, substantiates the finding of Fox (1939), that the animals store the pits and discard the pulp. A similar observation was made by R. K. LeBarron, of the Lake States Forest Experiment Station, who found near Tofte, Minn., little piles of dogwood pulp from which chipmunks had extracted the pits. The presence of pulp in one stomach, however, proves that the fleshy part of the fruit is not always discarded.

Products of plant genera not further discussed were consumed infrequently and in small quantities. Table 1 lists these foods and shows their importance in the chipmunks' diet.

Unidentified plant material includes parts too finely masticated for identification or those without diagnostic characters. Among this material was the endosperm of a seed, probably of the grass family, and oily nut-like fragments from seeds.

Although the green achenes of the large-leaved aster (*Aster macrophyllus*) were not found in stomachs or cheek pouches, they are listed as part of the August food. On many occasions the writer and forestry personnel have observed chipmunks cutting off the flower heads of this aster and retiring to the tops of nearby rocks to extract the green achenes.

On several occasions the animals have been seen gathering the seeds and silky attachments of the fireweed (*Epilobium angustifolium*). One chipmunk was shot while in the act of collecting this seed, with which its mouth was completely filled. Whether the animals take this material for the sake of the seeds or to use the down as bedding is not known, but it is likely that they utilize both.

DISCUSSION

The high frequency of animal food, especially of such forms as lepidopterous larvae and grasshopper eggs, which were found in large quantities in the stomachs, indicates a beneficial influence on the part of chipmunks. It is very probable that during June and July, when insects are even more numerous in the forest than in August and September, they may be consumed in still greater quantities.

The part chipmunks and other small rodents play in controlling forest insects is not known, but normal rodent populations often exceed in numbers the birdlife in an area. The public is readily convinced of the importance of birds in insect control, but they either ignore the small rodents, which may be equally valuable in this respect, or consider them entirely harmful.

The bird remains in the food of the chipmunks studied were too fragmentary to give reliable clues as to their source. They may have been from carrion or they may have represented kills by the chipmunks.

The lack of significant quantities of tree seeds in the stomachs and cheek pouches examined does not mean that chipmunks have no importance in relation to trees. The dominant conifers in the areas where the animals were collected were jack pine and black spruce. Both species discharge their seeds gradually, with the result that a chipmunk has but a small chance of finding many seeds at one time, except when cone-bearing slash is abundant on the ground.

Of the 28 genera of seeds identified in this study only 5 are adapted for wind dispersal. Distribution of the others depends chiefly on animal transport. Dissemination may be effected in two ways: By mechanical transportation to caches or by being voided as excrement at places some distance from the point of origin. Many seeds, as those of *Chiogenes*, *Rubus*, and *Vaccinium*, which were common in the stomachs, had passed through the mouth without injury by the animal's teeth and were free to go through the body unharmed and possibly improved for germination. While there is no definte proof that digestion does not kill the seeds, apparently it does not injure them if they escape destruction by the teeth. *Vaccinium* seeds taken from black bear scats have been successfully germinated in our germination laboratory. Germination experiments with rose seeds that have passed through the digestive systems of sharp-tailed grouse have shown that these seeds are eight and one-half times as viable as those collected directly from plants. If the abrasion of the gizzard, the corrosive action of the digestive juices, and the effect of the high body temperature in birds are not injurious to certain seeds, it is not likely that the milder digestive action and lower body temperature of mammals have harmful effects.

The appearance, shortly after fires and logging operations, of herbaceous and shrubby growth, where these previously have been lacking because of

excessive shade, may in part be explained by distribution of the seeds of these plants by rodents and birds before the area was cleared.

Where chipmunks become abundant in mature white or red pine stands there is no doubt but that they consume large quantities of seeds. Under normal conditions, chipmunk populations are so low that of themselves they are not likely to exert an excessively detrimental influence on tree reproduction. Their influence, together with that of mice and seed-eating birds, however, might become notably injurious.

The subject of rodent ecology has been but slightly explored, and it is hoped that more attention will be given it throughout the country, so that we may speak with more certainty as to the animal factor in forest and range ecology.

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COLOUR PHASES OF THE RED FOX (VULPES FULVA) IN ONTARIO

By E. C. Cross

INTRODUCTION

Foxes of the genus *Vulpes* from Siberia and North America have three recognized colour phases:

(1) The red fox is reddish brown or fulvous with black markings on feet and ears, and a white tip on the tail.

(2) The cross fox is mostly red or fulvous but with an increased amount of black on the legs and underfur. The darkened guard hair on the shoulders and back forms the "cross" from which the animal derives its name.

(3) The silver-black fox has the red and fulvous fur replaced by black. White banded guard hairs which may be present in varying proportions are responsible for the "silver" effect. The tip of the tail is usually white in all three phases.

Two less well-known variations are the "samson" fox, which has a woolly pelt like that of the rex rabbit (owing to the absence of guard hairs) and the "bastard fox," an animal essentially similar to the red fox but having a smoky appearance (on account of an increased amount of dark pigment in the fur) and more extensive black markings on the legs and underparts.

The range in variation of these colour phases constitutes an almost perfect gradation in colour from the red to the black fox. The normal colour of the red fox merges through graded bastard foxes into light coloured cross foxes, on through progressively darker cross foxes to full silvers and so through animals having less and less silver to the pure black individual.

MATERIAL FOR THE STUDY

An opportunity of investigating the proportions and distribution of these colour phases of the fox population of Ontario was presented in 1936 when, through the courtesy of the Hudson's Bay Company, the records of the fur collected at the Company's Ontario posts since 1916 were presented to the Royal Ontario Museum of Zoology. These returns represent the actual number of pelts traded annually at each post. The posts themselves are distributed throughout the part of Ontario that lies north of Lake Nipissing (fig. 1), an area somewhat irregular in shape, extending north from the 46th parallel for more than 700 miles and a like distance east and west from the Quebec boundary to Manitoba.

The extent of the area, over 330,000 square miles, the period of time, twenty years, and the number of foxes, more than 100,000, may be considered adequate for a preliminary survey of the occurrence of colour phases in the fox population of this region.

COLOUR PHASE PROPORTIONS

The 105,105 foxes collected in Ontario during the period under review had the four colour phases in the following proportions:

Red foxes	74.7 per cent
Cross foxes	21.6 per cent
Silver-black foxes	3.2 per cent
Bastard foxes	0.7 per cent

FIG. 1.—Location of the Hudson's Bay Company's Ontario posts

The fur sales of the Hudson's Bay Company for the period 1850 to 1909 as supplied to the Commission of Conservation, Canada, may be cited for comparison (Jones 1914, p. 203–214). Some 880,000 fox pelts drawn from all over Canada were collected by the Company during this sixty-year period, and the proportions of colour phases were as follows:

Red foxes	74.3 per cent
Cross foxes	20.4 per cent
Silver-black foxes	5.1 per cent

The Canadian and the Ontario figures are in general agreement. That is, the red phase is most numerous, the silver-black phase is least numerous, and the cross phase is intermediate. The differences between the two groups, though not great, are significant and are traceable to the variations in the

TABLE 1.—*Percentages of the four colour phases among the foxes collected at the Hudson's Bay Company's Ontario posts 1916–1935*

POSTS	RED FOX	CROSS FOX	SILVER FOX	BASTARD FOX
Temagami	97.4	2.5		
Gogama	86.6	10.1	3.	.1
Missanabie	83.4	13.7	2.0	.7
Montizambert	78.8	15.5	5	.5
Nipigon	76.4	19.2	2.6	1.7
Mattice	72.9	21.7	4.2	.7
Dinorwic	76.5	20.6	2.1	.6
Long Lake	78	13	2.7	1.3
Nipigon House	81.3	16.5	1.9	.19
Minaki	79.4	17.1	.4	2.9
Hudson	76.1	20.2	2.5	1.06
Sioux Lookout	73.1	21.5	4.4	.8
Allanwater	74.4	20.6	3.4	1.5
Grassy Narrows	77.1	17.7	2.2	2.8
Cavell	84.8	13.6	.8	.8
Bucke	76.7	18.5	1.8	2.8
Lac Seul	76.5	18.4	3.9	1.07
English River	70.7	24.7	4.1	.3
Pine Ridge	72.9	21.6	4.6	.7
Red Lake	77.5	18.5	3.5	.3
Osnaburgh	74.7	20.4	3.3	1.2
Moose Factory	74.1	21.6	4.2	.2
Fort Hope	71	23.9	3.6	1.1
Ogoki	68.9	26.1	4.1	.7
Cat Lake	72.6	22.8	2.8	1.7
Albany	69.5	25.5	4.5	.3
Lansdowne	74.1	20.8	3.2	1.8
Deer Lake	77	20.5	2.2	.3
Attawapiskat	71.3	24.7	3.7	.4
Trout Lake	69.1	26.2	4.4	.16
Weenusk	72.8	22.8	3.5	.3
Severn	70.5	24.3	4.7	.1

proportion of red, cross and silver-black foxes which exist in different parts of Canada.

GEOGRAPHIC VARIATION IN COLOUR PHASE PROPORTIONS

In Ontario itself wide variation exists between individual posts in the proportion of red, cross and silver-black foxes collected since 1916 (table 1). The percentage of red foxes varies between 68.9 per cent and 97.4 per cent,

the percentage of cross foxes varies from a low of 2.5 per cent to a high point of 26.2 per cent and the silver-black fox percentage ranges from nothing at all to 5 per cent.

It has long been believed by trappers and others that a progressive increase in the proportion of cross and silver-black foxes occurs from south to north and that these colour phases reach their greatest incidence in the north.

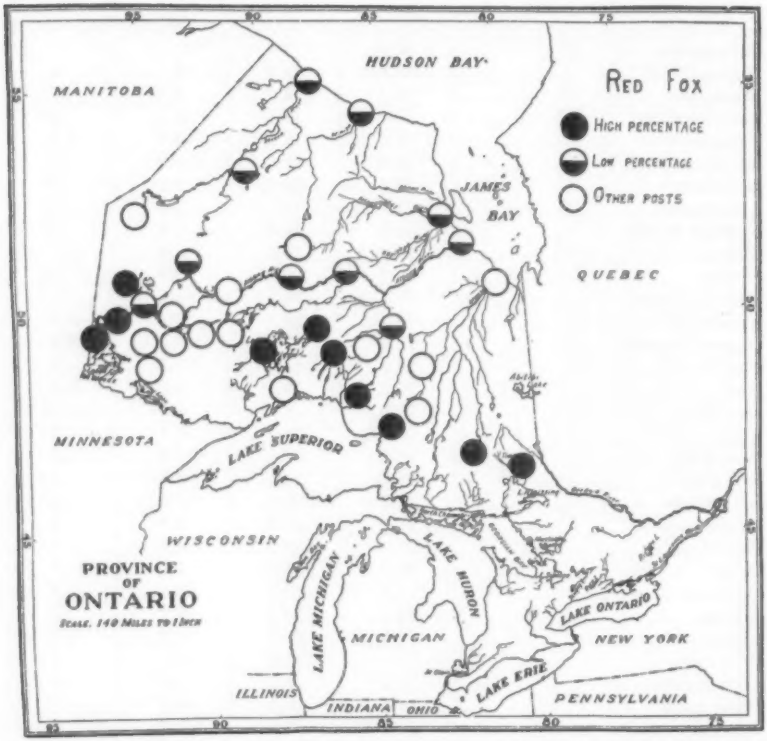

FIG. 2.—The ten posts of the Hudson's Bay Company in Ontario that collected the highest percentage of red fox pelts from 1916 to 1938, and the ten posts that collected the lowest percentage of red fox pelts during the same period.

The thirty-two posts in table 1 are listed in a south-north progression from Temagami to Severn. It may be seen at a glance that neither the red, the cross nor the silver-black fox presents anything like a uniform progression. Eliminating the two southern posts, Temagami and Gogama, which must be considered as doubtful cases on account of the small number of foxes collected, the lack of progression from south to north is accentuated.

The distribution of high and low percentages is, however, not erratic, as may be seen from examining the maps in figures 2, 3, 4 and 5 wherein the ten posts with the highest percentages and the ten posts with the lowest percentages are plotted.

The red fox (fig. 2) shows a group of high percentage posts in the southeast and another group in the southwest, with an area of low yiel between.

FIG. 3.—The ten posts of the Hudson's Bay Company in Ontario that collected the highest percentage of cross fox pelts from 1916 to 1938 and the ten posts that collected the lowest percentage of cross fox pelts during the same period.

The most northern section of the province is an area of definitely low percentages for the red fox.

The cross fox (fig. 3) is almost the exact reverse of the red, with low percentage areas in the southeast and southwest and high percentages throughout the northern district.

The silver-black fox (fig. 4) shows a group of high percentage posts in the

east from Lake Superior to James Bay. Four other high yielding posts occur, two in the southwest and the other two in the northwest. The south is in the main a low percentage area for the silver-black fox.

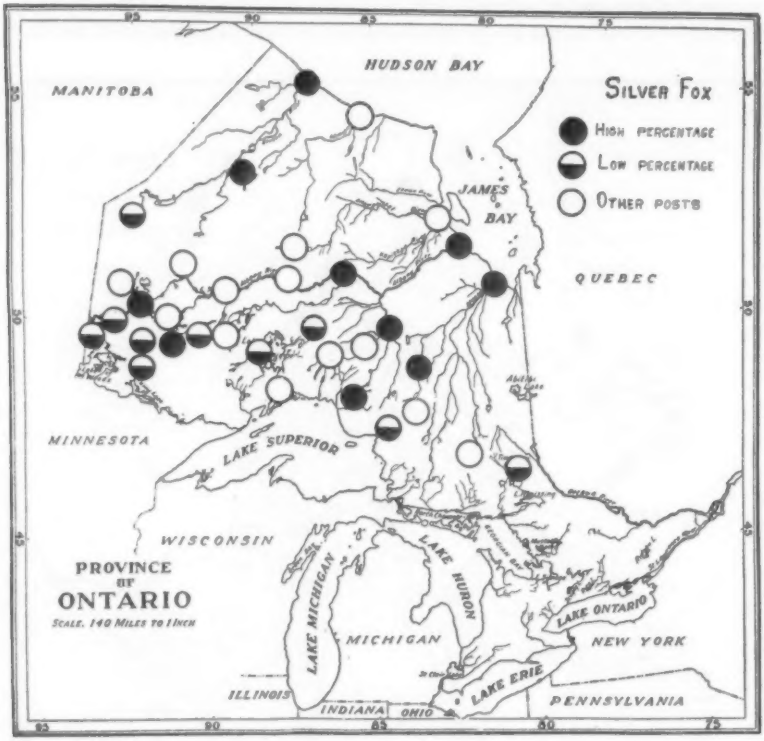

FIG. 4.—The ten posts of the Hudson's Bay Company in Ontario that collected the highest percentage of silver-black fox pelts from 1916 to 1938 and the ten posts that collected the lowest percentage of silver-black fox pelts during the same period.

The bastard fox (fig. 5) shows a clump of high percentage posts directly north and west of Lake Superior, surrounded on all sides by low percentage areas.

Red foxes in general have their highest incidence in the south and decrease as one proceeds north, but there are many exceptions. Cross foxes in general have their lowest incidence in the south and increase northerly, but again there are many exceptions. Silver-black and bastard foxes show so many

exceptions to a north and south progression as to well rule such progression out of consideration.

It will be seen from these maps as from table 1 that there is not a clear progression from north to south among any of the four colour phases. It is

FIG. 5.—The ten posts of the Hudson's Bay Company in Ontario that collected the highest percentage of bastard fox pelts from 1916 to 1938 and the ten posts that collected the lowest percentage of bastard fox pelts during the same period.

evident then that in Ontario latitude alone does not determine the proportions of red, cross, or silver-black foxes.

ANNUAL VARIATION IN COLOUR PHASE PROPORTIONS

The percentage proportions of red, cross, silver, and bastard foxes vary from year to year in the post collections. When the annual figures for individual posts are compared great variation is found. The proportions of

these four phases are shown in percentages in tables 2 and 3 for two typical posts.

The only apparent correlation of these percentages with periods of abundance and scarcity is that the greatest variations occur during the time of scarcity. Compare Attawapiskat 1920 to 1921 and 1930 to 1931; Deer Lake, 1919 to 1921 and 1930 to 1932. This, however, is probably a statistical effect induced by the small number of foxes collected at a given time and thus constituting an unsatisfactory sample. The periods of greatest fox

TABLE 2.—*Percentages of the four fox colour phases in the annual collections of the Hudson's Bay Company post at Deer Lake, 1916–1938*

(Year of maximum numbers marked with + sign, year of minimum with − sign)

YEAR	RED	CROSS	SILVER	BASTARD
+1916	68.8	28.4	2.7	
1917	81.3	16.2	2.3	
1918	67	30.6	2.2	
1919	54.5	39.3	6	
−1920	70	30		
1921	64.7	23.5	11.7	
1922	81.2	17.1	1.5	
1923	75.6	13.4	2.5	
1924	76.8	12.4	.6	
1925	80.5	16.2	3.2	
+1926	76.4	18.5	3.4	1.4
1927	66.1	29.5	2.6	1.6
1928	76.6	18	4.1	.9
1929	74.5	24.5	.9	
1930	73.4	21.6	4.9	
−1931	78.5	20.4	1.0	
1932	81.2	18.7		
1933	76.5	22.0	1.3	
1934	79.5	19.6	.8	
+1935	75.3	22.1	2.2	.3
1936	79.8	17.5	2.5	
1937	82.6	14.6	1.6	1.0
1938	79.4	18.7	1.8	

abundance should theoretically provide a more satisfactory sample but even then considerable variation does exist. See years marked with plus sign in tables 2 and 3.

This lack of uniformity may be shown by comparing the highest and lowest percentages at these two posts. At Attawapiskat the red foxes range from a low of 52.9 per cent to a high of 91.6 per cent; the cross foxes, from 9.3 to 47 per cent; the silver-black foxes, from zero to 6.4 per cent and the bastard foxes from zero to 1.4 per cent. Deer Lake is almost as variable, with its

red foxes ranging from 54.5 to 82.6 per cent; cross foxes, from 12.4 to 39.3 per cent; silver-black foxes from zero to 11.7 per cent and bastard foxes from zero to 1.6 per cent.

PROGRESSIVE ALTERATION IN COLOUR PHASE PROPORTIONS

In table 4 is recorded in percentages the proportion of red, cross, silver-black and bastard foxes calculated for the total annual collection of all the Ontario posts. The figures show a year to year variation, as do those of

TABLE 3.—*Percentages of the four fox colour phases in the annual collections of the Hudson's Bay Company post at Attawapiskat, 1916–1938*

(Year of maximum numbers marked with + sign, year of minimum with − sign)

YEAR	RED	CROSS	SILVER	BASTARD
+1916	70.8	22.6	6.4	
1917	67.9	26.8	5.2	
1918	71.8	24.2	3.9	
1919	78.4	19.6	1.9	
−1920	91.6	9.3		
1921	52.9	47.		
1922	79.7	20.2		
1923	76.4	21.5	2.0	
1924	75.3	23.	1.5	
1925	69.6	27.7	3.6	
+1926	69.2	26.6	4.0	
1927	70.1	26.6	3.2	
1928	69.8	26.7	3.3	
1929	72.0	24.8	3.2	
1930	64.1	33.6	2.1	
−1931	66.1	27.9	4.4	1.4
1932	76.0	20.1	3.7	
1933	70.6	27.1	2.2	
+1934	73.9	21.1	4.8	
1935	73.1	21.8	4.6	.5
1936	68.6	27.3	4.0	
1937	80.1	17.7	2.0	
1938	76.4	19.8	2.6	1.1

individual posts; but in addition these percentages, over the 23 years, indicate that a change in proportion may be in progress.

The red fox percentage which stood at 70.5 in 1916 had advanced to 79.5 per cent by 1938. The percentage of cross foxes on the other hand had declined from 24.2 in 1916 to 18.1 per cent by 1938, and the proportion of silver-black foxes had likewise been reduced from 5.1 in 1916 to 1.8 per cent in 1938.

Since many new posts had been established by the company during this period, it was possible that collections from new territories had affected the

totals. Accordingly the percentages of red, cross, silver-black, and bastard foxes were calculated for the 21 posts that had operated continuously from 1916 to 1938. The percentages of the first five years (1916–1920) as against those of the last five years (1934–1938) are shown in table 5.

The same trend is shown by these figures. All the posts but one show an increased percentage of the red phase during the last five-year period over the first five-year period. As regards cross foxes the situation is reversed,

TABLE 4.—*Percentages of the four colour phases among foxes as shown by the annual fur collections of the Hudson's Bay Company in Ontario, 1916–1938*

(Year of maximum numbers marked with + sign, year of minimum with − sign)

YEAR	RED	CROSS	SILVER	BASTARD
+1916	70.5	24.2	5.1	.2
1917	71.2	23.9	4.0	.6
1918	72.8	23.3	4.3	.6
1919	70.8	24.4	4.2	.5
−1920	71.0	22.9	4.0	2.0
1921	65.9	27.2	5.4	1.3
1922	77.0	19.7	2.9	.2
1923	74.8	20.6	4.2	.2
1924	72.3	23.9	3.3	.4
1925	71.3	23.9	4.3	.3
+1926	71.7	23.9	3.9	.3
1927	73.1	22.4	3.9	.4
1928	73.2	22.1	3.7	.8
1929	76.0	19.8	3.0	1.1
1930	71.8	21.5	5.3	1.3
−1931	73.3	22.7	2.7	1.2
1932	76.7	19.6	2.6	.9
1933	74.4	21.8	2.5	1.1
1934	74.8	21.1	3.3	.5
1935	77.0	19.2	2.3	1.3
+1936	78.8	18.1	2.1	.9
1937	79.1	17.8	2.0	.9
1938	79.5	18.1	1.8	.4

with all but two posts recording a decreased percentage of these animals. Silver-black foxes follow the downward trend of the cross phase. Four posts record an increased percentage; but at two of them, Gogama and Grassy Narrows, the collections during the first five-year period were so small that the proportions recorded for the 1916–1920 period are probably of slight significance. The average percentage for these two five-year periods for all the Ontario posts as shown by the following figures may be cited for further comparison.

	Red	*Cross*	*Silver-black*	*Bastard*
First period (1916–1920).....	71.1%	23.9%	4.4%	.4%
Second period (1934–1938).....	78.0%	18.7%	2.2%	.9%

This progressive change in the composition of the fox population is comparable to a "breeding out" of the cross and silver-black phenotypes. It is a remarkable fact that while the percentages of cross and silver-black foxes collected have decreased, the actual number of skins representing these phases has increased during the period 1916 to 1938. Though cause or

TABLE 5.—*Percentages of the four fox colour phases during two five-year periods as shown by the collections at twenty-one Ontario posts operated continuously from 1916 to 1938*

POST	5 YEAR PERIOD, 1916–1920				5 YEAR PERIOD, 1934–1938			
	Red	Cross	Silver	Bastard	Red	Cross	Silver	Bastard
Albany	73.1	22.4	3.8	.2	74.0	21.2	3.5	1.1
Attawapiskat	71.1	24.1	4.6		73.6	22.0	4.0	.2
Deer Lake	68.6	28.5	2.8		78.4	19.5	1.8	.07
Dinorwic	75.1	18.9	5.8		79.8	17.3	1.4	1.3
English River	72.0	20.4	7.5		72.9	24.0	1.1	1.8
Fort Hope	63.8	31.4	4.2		81.9	17.0	.2	.7
Gogama	91.3	8.6			92.9	5.7	.5	.7
Grassy Narrows	78.8	19.2		.9	78.6	17.3	1.4	2.6
Lac Seul	74.4	19.5	4.4	1.5	81.0	16.6	2.0	.2
Long Lake	72.4	19.9	3.3	2.0	87.5	10.9	1.6	.8
Missanabie	81.1	16.2	2.5		84.7	12.3	.7	2.1
Montizambert	82.0	13.2	4.7		82.4	13.2	4.0	.2
Moose Factory	74.9	21.6	3.4		82.8	14.2	1.9	.9
Nipigon	78.1	20.2	1.5		83.0	10.2	3.3	3.3
Nipigon House	72.6	25.5	1.9		81.6	17.1	1.2	
Ogoki	66.9	24.6	8.5		70.5	26.3	2.7	.3
Osnaburgh	70.0	22.4	6.3		80.7	16.5	1.2	1.4
Severn	69.5	26.5	3.8		72.8	22.2	4.8	.08
Temagami	93.5	6.5			95.4	3.6		
Trout Lake	65.6	30.0	4.2	.1	74.8	22.2	2.8	
Weenusk	70.9	25.8	3.2		80.2	16.0	2.7	.9

causes of this alteration in the genetic pattern of Ontario foxes is unknown, it must be related in some way to the genetic basis of the phenotypes concerned.

GENETIC BASIS OF FOX COLOUR PHASES

Before the establishment of the fox ranching industry little was known as to the genetic basis of fox colour phases other than that litters of wild foxes consisting of red and silver pups, of red and cross pups, and of red and cross and silver pups had been found. In 1928 the United States Department of

Agriculture instituted an investigation into the basic differences between red, cross and silver foxes. This project was carried out by Hanson of the United States Fur Animal Experiment Station and Warwick of the Texas Agricultural Experiment Station (Ashbrook, 1937).

The hypothesis developed was that two pairs of genes and their alternate forms (allels) account for the colour phases of foxes. Nine types were described, red; cross; Alaskan silver; smoky red; blended cross; sub-Alaskan silver; standard silver; sub-standard silver; black. It was postulated that two distinct mutations to silver had occurred in the North American fox population. One referred to as the "standard" had arisen somewhere in northeastern North America, the other, known as the "Alaskan" had arisen somewhere in Alaska. The allels are complementary and when crossed the epistatic condition of a partly red animal results; this is known as the "patch" or "cross" fox.

On the basis of this hypothesis the presence of wild cross foxes in any locality is dependent on the appearance of these complementary allels in the local fox population and the concentration of these genes determine the number of cross foxes. Wild cross foxes are to be found in varying proportions from New Mexico to the Arctic circle and from Siberia to Ungava. To account for this distribution it would therefore be necessary to assume that these complementary genes had somehow been distributed to the limits of this vast range, among populations specifically distinct in other characters. In the light of our present knowledge of the classification, range and distribution of foxes this seems to be improbable. A cross fox arising from a mating of Alaskan and "standard" foxes does not necessarily prove such mating to be the only source of cross foxes.

THE CROSS FOX IN ONTARIO

The figures quoted in tables 1 and 5 display evidence of the wide range in variation of these fox colour phases, in time and space, referred to earlier. These variations, however, do not obscure the fact that as the red fox percentage increased the percentage of both cross and silver-black foxes decreased. Add to this the fact that the cross fox is intermediate in numbers between the red and silver-black foxes, then these data might almost be regarded as proof of the hybrid character of the Ontario cross fox.

THE BASTARD FOX IN ONTARIO

The "bastard" fox of the Hudson's Bay Company's records, the "bastard" fox described in "Fur Farming in Canada" (Jones, 1914, pp. 21–22) and the "smoky red" fox of Warwick and Hanson, (Ashbrook, 1937, p. 1390) appear to be identical. Jones records the bastard fox as the progeny of red and silver parents and remarks that this phenotype was widely used by fox ranchers in the early days before sufficient silver animals were available. Hanson's

chart reproduced by Ashbrook (1937, p. 1391) shows "smoky red" to be the progeny of a red-silver mating and also to be produced when cross foxes were mated to silvers or when blended cross foxes were bred *inter se*. It is, however, doubtful if data obtained from the matings of racially mixed foxes such as Hanson used are applicable to the wild fox population of Ontario.

From the data now at hand the bastard fox must be regarded as a hybrid form, and the proportion of bastard foxes should probably be much greater than the figure given in the Hudson's Bay Company's records. It is probable that only the more extreme examples of this phenotype are separately recorded by the trading posts. Many of these animals may be included in the figure for red foxes, as the darkening of the pelts would not be great enough to be of significance in the fur trade. There is some experimental evidence to support this proposition in that red foxes of normal appearance when bred proved to be hybrids carrying red and black genes as do bastard foxes (Ashbrook, 1937, p. 1390).

GENETIC COMPOSITION OF THE ONTARIO FOX POPULATION

Without additional data from experimental matings of wild-caught Ontario foxes, it is quite impossible to come to any certain conclusions as to the genetic basis of the fox population of the province. As a guide to such proposed test matings, however, it has seemed worth while to formulate a tentative hypothesis based on the figures from the Hudson's Bay Company's posts and other available data.

The average figures for all foxes collected during the 23 years were recorded earlier in this paper as follows:

Red foxes	74.7 per cent
Cross foxes	21.6 per cent
Silver-black foxes	3.2 per cent
Bastard foxes	0.7 per cent

If a single pair of genes and their allels govern these colour phases then to produce 3.2 per cent of silver-black foxes the figure for hybrid foxes is too low, and the figure for red foxes is too high. Theoretically, the figures should be, red foxes 66.5 per cent and cross foxes 30.3 per cent, if cross foxes represent the hybrid group.

I have already pointed out that the proportion of bastard foxes recorded in the Hudson's Bay Company's records is probably too low and have suggested that the missing bastard foxes had been included with the red fox figures. If we then deduct from the recorded number of red foxes the amount by which they exceed the theoretical figure quoted, combine that amount with the 0.7 per cent of bastard foxes, and add the whole to the cross fox figure of 21.6 per cent the theoretical requirements for a single pair of genes,

and their allels are met. The following figures give the percentages corrected to the theoretical requirements:

Red foxes	66.5 per cent
Hybrid group (bastard and cross foxes)	30.3 per cent
Silver-black foxes	3.2 per cent

On the basis of these data then it is tentatively suggested that the colour phases in the Ontario fox population are governed by a pair of genes and their alternates, red foxes and silver-black foxes being the respective genotypes. The bastard foxes and cross foxes constitute the hybrid group and their various gradations of colour, which blend almost insensibly into one another, are determined by secondary minor or modifying factors.

SOME MUSEUM IMPLICATIONS

Red, cross, and silver-black foxes were at one time classed as separate species because of their different colour patterns. At a later date, when it was discovered that these variants might occur in the same litter, their rank was changed to that of colour phases. Current taxonomic procedure accords subspecific rank to genetic patterns only when they are segregated geographically.

Standard taxonomic procedure, using characters of colour, size, skull proportions and so on, when applied to mammals allows rather distantly related groups such as genera and species to be classified satisfactorily. When an attempt is made to break down species into smaller units the results are sometimes more confusing.

The range of variation in a standard character such as colour among the groups composing geographic races or subspecies is often perplexing to the taxonomist. The genetic patterns responsible for this diversity are probably not basically dissimilar in kind or mode of transmission to those found among the Ontario foxes (compare Dice, 1939).

While records of the occurrence of genetic patterns such as recorded by the Hudson's Bay Company for the red, cross, and silver-black foxes are rare, a mass of similar data is available in museum collections. The mammal collections in our museums have been built up primarily for taxonomic and distributional studies and in consequence do not constitute a satisfactory sample of the population for exhaustive genetic analysis. Nevertheless in many groups the collections are sufficiently adequate for preliminary genetic studies.

Problems that involve consideration of the various genetic patterns found among related populations have been termed "population genetics" and constitute a field that taxonomists and ecologists are being forced to enter in order to understand the animal groups with which they propose to work.

CONCLUSIONS

The incidence of colour phases in the Ontario fox population is determined by a number of factors most of them unknown and of which latitude is but one.

The proportions of the colour phases in the Ontario fox population vary both in time and space.

The silver-black and cross colour phases have undergone progressive reduction in the Ontario fox population during the last 23 years and the red phase has increased proportionally.

A tentative analysis of the genetic constitution of the Ontario fox population, on the basis of the available data, suggests that a single pair of genes and their alternates govern the colour phases of Ontario foxes. Red and silver-black foxes are the genotypes with cross foxes and bastard foxes constituting the hybrid group.

It is suggested that museum collections may offer sufficient material for preliminary genetic analysis of some racial groups. Such tentative conclusions need to be checked by experimental breeding. This field of "population genetics" is being forced upon the attention of taxonomists and ecologists at the present time.

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IDENTIFICATION OF MICE IN GENUS PEROMYSCUS BY A RED BLOOD CELL AGGLUTINATION TEST

By Paul A. Moody

For a number of years the writer has been searching for serological means of studying the inter-relationships of the many species and subspecies of *Peromyscus*.

Levine and Moody (1939) applied the precipitin test to study of the relationships of a series of rodents: woodchuck, gray squirrel, pocket gopher, white-footed mouse, cotton rat, wood rat, muskrat, roof rat and porcupine. Relative to the ability of the precipitin test to distinguish between the sera of closely related forms, they found that "rodents of different superfamilies were separated very readily; families and subfamilies within the same superfamily were distinguished from one another; in many instances it was possible to differentiate closely related genera within the same subfamily." But attempts by the writer to differentiate between species within genus *Peromyscus* by means of the precipitin test have been unsuccessful (unpublished data). Hicks and Little (1931) reported differentiation between species within genus *Mus*, as did Avrech and Kalabuchov (1937) within genus *Apodemus*. Wolfe (1939) has described a method for the production of highly specific antisera; if it should prove possible by this means to produce antisera of increased specificity against *Peromyscus* sera, differentiation between species within the genus might be attained. Recent work by Boyden (1939) suggests that use of the photronreflectometer may increase the differential sensitivity of the precipitin reaction beyond that attainable with the ring test.

The writer has also attempted to apply the Schultz-Dale test to the study of *Peromyscus* relationships (Moody, 1940). This test, based upon sensitization of guinea pig uterine tissue, is somewhat more sensitive than is the precipitin test. Under optimum conditions, differentiation between the sera of different species within the genus was obtained.

The preceding tests depended upon the specificity of serum proteins. That the red blood cell proteins might prove more narrowly specific than did the serum proteins was suggested by the results of Landsteiner and Miller (1925) with the cells of primates, of Irwin and Cole (1936 *et seq.*; Irwin, 1939) with those of pigeons, and of Gorer (1936) with mouse cells. Gorer investigated three strains of mice: agouti, albino and black. Unadsorbed antisera did not distinguish between their red blood cells but use of adsorbed antisera made possible analysis of the serological constitutions of these cells.

The present paper describes the nature of the agglutination test, the technique involved and its application to the problem of identifying which of a given series of mice belonged to *P. leucopus noveboracensis* and which belonged to *P. maniculatus gracilis*.

PRINCIPLE OF THE TEST

The principle of the test may be illustrated by the example diagrammed in figure 1. In this instance, red blood cells from *Peromyscus maniculatus* are inoculated into a rabbit. The latter is thereby stimulated to form antibodies against the foreign cells. These antibodies circulate in the serum of

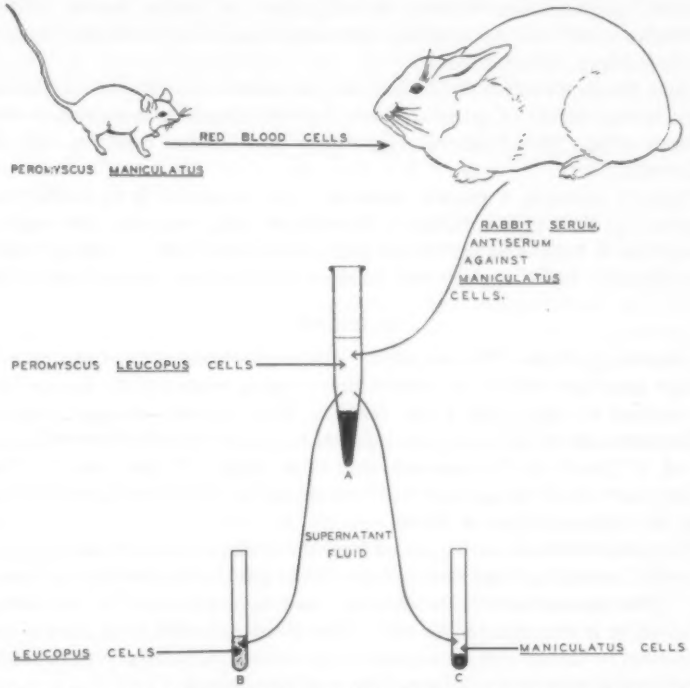

FIG. 1.—Example of the production and use of adsorbed antiserum for identifying red blood cells.

Antiserum against *maniculatus* cells is produced by the rabbit inoculated with them. In tube A antibodies capable of agglutinating *leucopus* cells are removed as a result of reacting with the latter. The supernatant fluid from tube A forms a delicate test fluid for distinguishing *leucopus* cells (not agglutinated; tube B) from *maniculatus* cells (agglutinated; tube C).

the rabbit and are, within limits, specific for the kind of cells which caused their formation.

A dilution of the rabbit serum, containing antibodies against *maniculatus* cells, is placed in tube A (fig. 1) and *leucopus* red blood cells are added. The proteins in the cells of the two species of mice are sufficiently similar so that

some of the antibodies evoked against *maniculatus* cells react with *leucopus* cells. The latter are clumped or agglutinated, as shown.

Small portions of the supernatant fluid from tube A are placed in tubes B and C. When *leucopus* cells are added to tube B no agglutination occurs, since all antibodies capable of reacting with *leucopus* cells have been removed by the reaction in tube A. When *maniculatus* cells are added to tube C, however, agglutination occurs, showing that the rabbit serum contains antibodies specific for *maniculatus* cells in addition to the antibodies removed by the *leucopus* cells in tube A.

Thus, the supernatant fluid from tube A, called now adsorbed antiserum, forms a test liquid of great delicacy for distinguishing *maniculatus* from *leucopus* cells. The fluid will agglutinate *maniculatus* cells but not *leucopus* cells.

Figure 1 presents a specific example. Its reciprocal is as readily performed. In that case a rabbit is inoculated with *leucopus* cells and the adsorption in tube A is performed with *maniculatus* cells. A testing fluid is thus obtained which agglutinates *leucopus* cells but not *maniculatus* cells.

TECHNIQUE

Collection of Cells.—The red blood cells were obtained from the mice by cardiac puncture with 1 ml. tuberculin syringes, using mouth suction after the method of Hicks and Little (1931). Ether anesthesia was employed. From adult mice of the size of those comprising species *leucopus* and *gossypinus* 0.5 ml. of blood can be removed with little danger of fatal result. From smaller individuals the amount removed should be less if it is desired to keep them as a future source of blood.

The collected blood was expressed from the syringe into a graduated centrifuge tube containing 3 per cent sodium citrate solution to prevent clot formation. The amount of citrate solution used approximated the amount of blood which it was planned to add. The blood collected from several mice was pooled to obtain sufficient quantity of cells for immunization of a rabbit.

Sterile glassware and solutions were used throughout.

Immunization of Rabbits.—The cells were washed* three times with 0.9 per cent buffered saline solution (Evans, 1922). A 30 per cent suspension of the washed cells in saline solution was prepared (3 parts packed cells to 7 parts saline). The rabbit received intravenously 1 ml. of this suspension each day for seven days. After an interval of seven days a second series of inoculations was given, using a freshly collected and prepared suspension of cells. The second series consisted of seven daily injections and was followed by a second rest period of one week. Finally, a third seven-day series of inoculations was given. Ten days following the last inoculation in this third

* The interested reader unfamiliar with the standard serological procedures mentioned is referred to such texts as Kolmer (1923) and Kolmer and Boerner (1938).

series a small sample of the rabbit's blood was taken by cardiac puncture. The serum was removed and tested for the presence of antibodies. Serum dilutions of 1:100, 1:500, 1:1,000 and 1:2,000 were prepared; 0.1 ml. of each dilution was pipetted into one of four small test tubes. To each tube was added 0.1 ml. of a 10 per cent suspension of homologous red blood cells (cells of the same kind as those injected into the rabbit). If agglutination occurred in the tubes containing the first three dilutions, the serum was considered to possess antibodies to sufficient potency. In that event, a greater amount of blood was removed from the rabbit by cardiac puncture. The blood was defibrinated by shaking with glass beads. The serum was obtained by centrifuging the blood and pipetting off the supernatant fluid. The serum was stored in the refrigerator in rubber-capped tubes or in sealed ampoules. Sterile glassware was used and asceptic precautions were observed throughout.

Adsorption of Serum with Heterologous Cells.—The cells for use in adsorption (tube A, fig. 1) were collected from mice of the heterologous species by the technique described above. The blood was citrated and the cells were washed three times with saline solution. The rabbit serum was diluted 1:100; approximately five parts of this dilution were added to one part of the packed heterologous cells. Cells and serum dilution were mixed thoroughly and allowed to stand at room temperature for two hours, with occasional shaking. Finally the tube was centrifuged and the supernatant fluid was removed and stored in the refrigerator. The fluid was found to retain its potency for at least three or four weeks.

Tests with the Adsorbed Antiserum.—The cells to be tested were collected by cardiac puncture using syringes into which a small quantity of citrate solution had first been drawn. The cells were citrated carefully to prevent any trace of clotting and were washed twice with saline solution. To insure against loss of sensitivity, cells were tested within 24 hours following collection. An approximate 10 per cent suspension was prepared by adding, from an ordinary bent pipette, four drops of packed cells to 0.9 ml. of saline solution. A suspension so prepared has sufficient accuracy for the purpose and its simplicity commends it when small samples of blood from individual mice are being tested.

Each mouse was represented by two small test tubes. The first tube received 0.1 ml. of the supernatant fluid (adsorbed antiserum). The second tube received 0.1 ml. of saline solution and served as a control. To each tube was added 0.1 ml. of the red blood cell suspension from the mouse.

The tubes were shaken and allowed to stand at room temperature for two hours, with occasional shaking. Finally the tests were read and the results were recorded with the following symbols: ++++, strong reaction, cells clumped into a consolidated pellet at the bottom of the tube; +++, large clumps formed but not thoroughly consolidated; ++, small clumps visible

to the naked eye; +, no clumping visible to the naked eye but clear-cut clumping shown by examination with the microscope; ±, doubtful; −, no agglutination revealed by the microscope.

The control tube of each pair served as a check on the presence of tiny blood clots which might be mistaken for the product of specific agglutination if observed in the tube containing adsorbed antiserum. Whenever cells of "unknown" mice were being tested, cells known to belong to the homologous and heterologous species concerned were tested as additional controls.

USE OF THE TEST IN IDENTIFYING PEROMYSCUS COLLECTED ON MT. MANSFIELD, VERMONT

Table 1 records the results of tests on a series of mice collected by Harrison A. Cooke, Jr. at various locations on Mount Mansfield, Vermont, during the spring and summer of 1939. The first column of the table gives the number of each individual. The second column records the reaction of each individual's cells with an antiserum prepared against *P. maniculatus osgoodi* cells and adsorbed with *P. leucopus noveboracensis* cells (as shown in fig. 1). The writer is indebted to Dr. Lee R. Dice, Laboratory of Vertebrate Genetics, University of Michigan, for the *osgoodi* stock. The third column shows the results of the reciprocal test, i.e.—employment of an antiserum against *leucopus noveboracensis* cells adsorbed with *maniculatus osgoodi* cells. In the fourth column appear the results of a few tests in which the anti-*leucopus* antiserum was adsorbed with cells from a few of the tested individuals which previously had been shown to be *maniculatus*.

The table shows clearly that the cells of most of the mice reacted with one of the adsorbed antisera and not with the other. Individual differences in intensity of reaction, as indicated by varying number of "pluses," probably reflect varying sensitivity of the cells; the significance, if any, is not apparent at the present stage of the investigation.

From the results given in table 1, the conclusion is warranted that mice No's. 1, 5, 7, 10, 14, 15, 16, 17, 18, 19, 20, 21 and probably 6, 9, and 12 are *maniculatus* (presumably *gracilis*) and that No's. 3, 22, 23, and 33 are *leucopus*.

Dr. Lee R. Dice has kindly cooperated by examining most of the living specimens. From observation of pelage, anatomy and behavior he has concluded (1940) that the above identifications are correct.

The results with mice No's. 6 and 12 (also No. 9, which died before tests could be completed) appear somewhat anomalous. The stronger reaction of the cells was with adsorbed anti-*maniculatus* serum. Yet the cells also reacted with adsorbed anti-*leucopus* serum, even when the adsorption was performed with cells from mice presumably belonging to the subspecies *maniculatus gracilis* (table 1, column 4). The writer has found that cells of hybrids react in this way with adsorbed antisera against both parent species (unpublished data; *cf.* Irwin and Cole, 1936). It is unwise to assume

that hybridization has occurred in this instance, however, since the serological constitution of genus *Peromyscus* has not yet been thoroughly explored. It may be noted, for instance, that an adsorbed antiserum may react with cells of a *third* species. Thus, the writer has found that an anti-*maniculatus* serum adsorbed with *leucopus* cells not only retains reactivity for *maniculatus* cells but also agglutinates *eremicus*, *gossypinus* and *polionotus* cells. It will

TABLE 1.—*Results of testing with two adsorbed antisera the red blood cells of a series of mice collected on Mt. Mansfield, Vermont*

See text for interpretation of symbols

MOUSE NO.	RAB. 136 (ANTI-MANICULATUS) ADSORBED WITH LEUCOPUS CELLS	RAB. 127 (ANTI-LEUCOPUS) ADSORBED WITH MANICULATUS OSGOODI CELLS	RAB. 127 (ANTI-LEUCOPUS) ADSORBED WITH MANICULATUS GRACILIS* CELLS
1	++	−	
3	−	++	
5	++	−	
6	++	±	+
7	+	−	
9	++	±	
10	+	−	−
12	+++	+	+
14	++++		
15	++	−	
16	+++	−	
17	++	−	
18	+++	−	
19	+	±	−
20	++	−	
21	+++	−	−
22	−	+	++++
23	−	+	++
33	−	+	++
Controls:			
maniculatus osgoodi	+++	−	−
maniculatus artemisiae	++++, ++	−	−
leucopus noveboracensis	−	+, +++	++++

* From mice No's. 1, 5, 15 and 16.

be well, therefore, not to attempt to explain the reaction of the cells of mice No's. 6 and 12 with adsorbed anti-*leucopus* serum until more extensive studies have broadened knowledge of serological relationships within genus *Peromyscus*.

An additional related point should be emphasized. From the fore-going discussion it will be evident that a test set up as described and as diagrammed in figure 1 can only be regarded as positively identifying individuals when but two possibilities are present, as when it is known that only two species

are inhabiting a given area. Thus, in the test shown in figure 1, "unknown" cells failing to react, as in tube B, are proven *not* to be *maniculatus* cells. Cells reacting, as in tube C, are thereby demonstrated to be *maniculatus* cells *only* if the specimens were collected in a region in which *leucopus* and *maniculatus* are known to be the only species present. If there were any possibility that a third species (*gossypinus*, for example) might also be present, it would be necessary to adsorb the supernatant fluid from tube A *a second time*, this time employing known cells from this third species. Following this second adsorption, a positive reaction, as in tube C, could safely be regarded as indication that the "unknown" cells belonged to *maniculatus*. A reciprocal test employing adsorbed antiserum against the third species (i.e.—*gossypinus*) should also be made.

SUMMARY

1. A blood test for the identification of mice in genus *Peromyscus* is described. Rabbits are immunized to the red blood cells of one species. Of the serum antibodies so produced those capable of reacting with the cells of a second species are removed by adsorption. The adsorbed antiserum then forms a delicate test fluid for distinguishing between the red blood cells of the two species.

2. The utility of the test is illustrated by its application to the identification of a series of mice collected on Mount Mansfield, Vermont. The test distinguished those individuals belonging to species *leucopus* and those belonging to species *maniculatus*.

Other problems in which a test of this type may prove of value in identifying closely related forms will readily suggest themselves to mammalogists.

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SOME CRITERIA FOR DETERMINING PROPER FORAGE UTILIZATION BY BIG GAME ON WINTER RANGES

BY LLOYD W. SWIFT

There is ample evidence to show that deer and elk numbers throughout the United States were generally at a low level around the turn of the 19th century. A realization of this situation by the public and the game authorities naturally led to a support of measures designed to preserve and restore the big-game populations. Consequently, restrictive laws were enacted, resulting in various degrees of protection through application of short or closed seasons, buck and bull laws and small bag limits. In addition, a vast refuge system was created and increased effort directed to law enforcement and control of predatory species. All these measures, separately and in combination, were effective in bringing about an increase of the deer and elk.

Since the need for protection was fully accepted by the public, there was general support for the program. Neither the public nor the game officials, however, realized the effectiveness of the measures applied, so were not prepared for the events that followed. Consequently, the rapid build-up of the big-game herds in many places reached serious proportions before the actual extent of overpopulations was recognized.

A number of the big-game concentration problems have attained national recognition. Perhaps the first was the Kaibab, in northern Arizona, a National Game Refuge, where hunting was prohibited and the deer further protected through active predator control. The rapid increase of the herd, the destruction of the range and the subsequent heavy death loss are all a matter of record. Perhaps not so fully known is the fact that for the past ten years the Kaibab area has supported probably only one-fifth as many deer as could have been maintained had the overstocking been prevented.

Other instances of overpopulation and destruction of game range are well-known. Pennsylvania, with white-tailed deer locally exterminated in 1900, now has an estimated population of nearly a million, and with it, many deer problems. In Michigan, the white-tailed deer are believed to number nearly a million and the magnitude of the problems such a population has created is fully presented in the Michigan Department of Conservation's recent publication, "White-tails, Presenting Michigan's Deer Problem." In the West, there is the John Day country, of eastern Oregon, involving excessive numbers of both mule deer and elk on the same range. Here, Cliff (1939) has shown that, because of direct competition, the larger and stronger elk are eliminating the deer in the struggle for the food. There is the Modoc mule deer winter problem in northeastern California, where the urge for food has resulted in the large mule deer herd removing the foliage from juniper to form a high or deer line on some 200,000 acres of winter range. Here, use is far ahead of annual growth on juniper and browse—yet as has often been demonstrated, large areas of grass are practically untouched. In Colorado, mule deer and elk problems are present in several areas, the most important and well-known being in the Gunnison territory.

The deer and elk overpopulations suggest two methods of attack, which for permanent solution must go hand in hand. They are to harvest the surplus numbers, preferably through hunter take of the necessary quota of the various sexes and ages, and to provide suitable and adequate year-long range. Obviously, the range factor is the more important, since its extent, condition and long-time capacity would naturally establish the number of big-game animals which should be maintained. This in turn would determine the size of the harvest which should be attained to keep the numbers of animals in balance with their available food supply.

As might be expected, it is the winter range which is usually the limiting factor of the yearlong game range. This is true for several reasons, but as pointed out by De Nio (1938) and other workers, the most noticeable is a definite restriction of the movements of the animals on account of the severity of winter snows and temperatures. Regions accessible at other seasons cannot be occupied because of snow depth, so that the deer and elk drift to lower elevations where food is exposed on wind-swept slopes or is available above the snow. Where snow is not too deep or crusted, deer and elk will paw away the snow to reach the plants, but except under especially favorable conditions, this sort of feeding is not likely to sustain them for very long periods.

In addition to the restrictions imposed by the winter season, the settlement and use of the land by man has prevented the use of much game winter range which at one time was entirely available to the big-game herds. This is especially true of the mountain valleys and foothill ranges, which are now settled and devoted to the production of crops and livestock. In some cases, settlements or heavily used lanes of transportation in passes and other areas

have blocked the seasonal migration lines and prevented the big game from following the ancestral routes between summer and winter territories.

Of course, there are instances where there is a shortage of big-game summer range, but in the main, the problems revolve around the conditions growing out of disturbances created by overpopulation on available winter range. Therefore, for the purpose of this discussion, the emphasis will be placed on the principles which apply primarily to big-game winter range conditions.

The determination of range overuse, especially in the early stages, is not an easy matter. Even when damage is rather obvious on the more important plant species, there may still be an honest difference of opinion on the seriousness of the damage and the principal cause. This arises out of perhaps two factors, the past use of the area by both game and domestic stock and the different food habits of these animals. It is true, for example, that many places in the West, now important as winter big-game range were depleted by excessive numbers of livestock before game became a factor. Hence in these instances, the game constitute an additional burden on land already suffering from insufficient plant cover and soil erosion. Naturally, in cases involving public lands, the urge is usually to remove the livestock. This may be effective, but unfortunately when such action seems necessary, the game populations are already so high their demands alone will prevent recovery of the range resource.

The other factor which leads to differences of opinion on the condition of the range arises out of food preferences. Cattle prefer grasses, and sheep, broad-leafed herbs. Deer prefer browse, and elk, grass. Stomach samples and other observation have shown that these game animals will attempt to forage so that at least 50 per cent of their food is made up of these plant groups. Furthermore, mule deer seldom take more than 20 per cent of their diet in grasses, and then only under certain seasonal conditions. In fact, the food preference is so strong, that mule deer have, on numerous occasions, actually starved to death on winter ranges where grass species were abundant, but browse plants were in insufficient amount. Although elk do use browse, in large quantities, they can, unlike mule deer, subsist on a range where the bulk of the plant food is composed of grasses and such grass-like plants as sedge.

The oft-repeated statement that big game and livestock will not occupy the same range, is certainly open to question. Perhaps the most frequent charge is that neither deer nor elk will use the same territory with domestic sheep. This sometimes appears to be true, but avoidance by game of an area occupied by livestock is probably based on reasons other than species incompatability. On the Sapinero area, in Gunnison County, Colorado, some of the greatest deer winter concentrations were on range used by sheep during the snow-free period. Elsewhere there are instances of big game using the same range with domestic stock.

No doubt, the presence of a herder, sheepdog and tepee are disturbing

to game animals on the sheep ranges, especially to elk. Most important, is the matter of food competition. If a range is overused by any class of stock or game, the competition for the remaining plant life is thereby heightened. Obviously, excessive numbers of either stock or big game make an area undesirable for themselves and undesirable for other species. The goal, then, should be to use our public ranges conservatively with either game or stock.

Regardless of whether livestock is a contributing factor or not, certain gross characters can usually be found on our western big-game winter problem areas. Where the game problem has existed for several years and the cumulative effect of overuse becomes well-marked, the following characteristics will usually be readily evident.

1. The preferred browse species will be in a most unsatisfactory condition. There will likely be parts or even whole shrubs dead. Living and dead portions available to the animals will be hedged as if clipped, or if irregular and ragged, will be devoid of current year growth.

Portions of the browse plants fortunate enough to exist beyond the reach of the hungry animals will have a normal open growth and look very different from the rest of the plant. Should the stand of browse be moderately dense, the removal of the twigs and foliage up to the limit of the browsing height will create a high line, which is commonly known as a deer or elk line, as the case may be.

Reproduction of the preferred browse species will probably be entirely absent and small plants that appear to be seedlings, on examination of growth rings, will be found to outdate the game concentration. Because of continued close cropping, these individual plants have never been allowed to attain anything more than seedling proportions.

Another manifestation of the overbrowsing will be lack of flowers and seeds on the overused portions. This would be on account of a reduction of the one year wood and the photosynthetic surface to a point where the plants' vitality was insufficient for production of reproductive parts.

2. Trees, on game winter problem areas, are likely to exhibit some of the same characters just described for browse plants. There will be a lack of reproduction, both of broad-leafed species as well as conifers. Aspen and juniper, especially, will exhibit a distinct browsing line and in cases of several years' standing, this character will also be exhibited by the pines and firs.

Where elk concentrate, they are likely to strip the bark from aspen with their front teeth. Although barking in itself may not be a sign of overuse, extensive barking seems to be rather definitely associated with overpopulations.

3. When the browse and tree conditions just described exist, the herbaceous cover is almost certain to be reduced both in quantity and quality. Perennial plants, of fibrous root systems, will be replaced by deep-rooted perennials of the weed type and by short-lived annuals.

Associated with the change in plant cover, there will be an obvious exposing of the soil surface. The reduced plant cover will neither by itself be sufficient to hold the topsoil in place, nor will it provide sufficient litter to protect the open soil between plants. Added to this, the excessive mammal population will repeatedly disturb the soil surface and prepare it for subsequent wind and water erosion. The result is sheet and gully erosion and disastrous reduction in site quality and the soil's ability to produce food for game species.

4. A final and shocking step that directs attention to the seriousness of winter game range deterioration, is the winter death loss of big game. This is nature's way of

leveling off and attempting to bring about a balance between numbers of game animals and carrying capacity of the winter range. Unfortunately, when abnormal winter losses do occur, the range is already seriously damaged. Range recovery thereafter is a matter of many years, even under conservative use.

The above conditions are associated with an advanced degree of overstocking. Anyone at all familiar with big-game food habits and normal plant growth and soil conditions could readily recognize the situation in its true proportions. A misleading situation sometimes occurs, in that plants seldom utilized by big game, even when there is a food shortage, may actually show good growth. This would be caused by a reduction of competition, through depletion of the heavily used species. Hence the growth response of non-food species may appear to reflect a satisfactory condition, especially to one not familiar with the plant and animal relationships. This emphasizes the need for game managers to know the plant species that make up the game diet.

The problem of game managers, and one which the public must recognize, is the importance of determining overpopulations before serious land and plant resource damage has occurred. This is not an easy matter, although the principles developed by workers in the field of range management can be readily applied to big-game winter range management.

How, then, can the game manager recognize the early stages of big-game overstocking, so that control measures can be applied before the plant and soil values are injured? If this can be done, the productivity of the land can be sustained and game animals provided for an indefinite period of time. The following points are offered as a possible guide to help in determining the initial stages of big-game overpopulations:

1. Key areas. It is a well-known fact that game, like livestock, are not naturally dispersed in a uniform manner over the territory they occupy. This is because of a number of factors, such as topography, vegetation types, and big-game species habits. Obviously, certain areas will be frequented much more than others, and therefore these areas are the ones where range abuse will first develop. If the overuse continues, the evidence will spread out from the heart of the key area.

On western winter big-game ranges, the key areas may be of several types. One very important determining factor is the snow depth, since the animals will likely be forced into the most limited portion of the winter range. These may be wind-blown ridges, warm south slopes, canyon bottoms, or foothills at the base of mountains. Even though the key areas may be a small part of the winter range, their value is much greater than their size would indicate. This is because the safe carrying capacity of the winter range during severe winters is in reality no more than the carrying capacity of the key areas. Consequently, they may determine the proper number of big-game animals, even though all other conditions may be exceptionally favorable.

2. When one has determined the key areas, the next step would be to ob-

that bees are not preferred and a change was made to meal worms (*Tenebrio molitor*). Milk and water were alternated for liquid.

Between May 3 and 19, nine of the eleven individuals died, mostly one or two at a time. (The cause of death is explained further on.) The remaining two seemed to get along well and are still alive and in excellent condition.

On May 25, Mr. Hays sent several more females from the same colony. The shipping box was damaged in transit, and all the bats escaped. Later on June 8, Mr. Hays came to Baton Rouge and brought with him four more females from the same colony at Robeline, which had been collected the day previous. All of these had parturiated, probably only a day or so previous. There were only 5 young with the 4 females. These four were placed with the two survivors.

The standard diet is still eggs, cheese and meal worms, but is varied whenever practical. The proportion of meal worms has been reduced to where each bat now receives approximately 4 to 5 three-quarters grown meal worm larvae. Like all species of bats that the writer has kept in captivity, the evening bat prefers a variety in its diet. All types of vegetables, fruits, and unsalted meats are readily accepted. Again like all the other species, cheese is the favorite above all. Buttermilk is often substituted for cheese, and is well liked. The flavor of mashed English peas is a particular favorite with this one species. All food must be crumbly, not too dry and not too moist, and must be in small pieces as they are unable to bite or tear pieces off of larger lumps.

All the original females of this colony examined contained two embryos each; none carried only one. Likewise, all embryos were approximately the same size. Those females sacrificed to the laboratory contained embryos measuring from 6 mm to 8 mm, crown-rump. There appeared as great a difference in length between the two embryos of one female as between any of the embryos of different females—which leads one to believe that all the embryos in all females are very nearly of the same age. Post mortem of the individuals that died between May 3 and 19 showed in every case two embryos, one or both of which were in an advanced stage of decomposition. It was obvious that all of these embryos were of the same age as those previously dissected. The uniformity of two embryos in every female without exception, and the slight variation in age, if any, are particularly worthy of record.

It is quite likely that the cause of death of the adult females was the death of the embryo. It seems that in most cases at least, as in rats and mice, dead embryos are resorbed rather than aborted. If resorbtion cannot take place, before decomposition sets in, death results.

Of the two surviving females of the first lot, one parturiated on June 5, during the day. The young were fully developed and appeared to be full term. One had been partly eaten, and the other was on the floor of the box,

intact within its membranes with the placenta attached. The second survivor parturiated the following day and both embryos were on the floor of the box, both enclosed in their membranes with placentae attached. The writer is inclined to believe that all of the embryos of both females were born dead.

It appears that an artificial diet, while sufficient for maintenance, is not suitable for embryonic development. All embryos of individuals kept in captivity died at one time or another. The lack of what particular article of food, if any, is responsible could not be ascertained. The supply of vitamins, and minerals and insect food should have been sufficient, but obviously something was lacking.

The five young of the four females brought in on June 5 seemed to be of the same age. There was very little size difference and they appeared to be about two to three days old. Mr. Hays' observations coincide with those of E. T. Hooper on *Nycticeius* (Jour. Mamm., vol. 20, p. 369, 1939), namely, that a number of young drop to the floor and are never recovered. Perhaps only half of the young are retained and have a chance of survival. This would be indicated by the fact that of the four females secured on June 7 there were but 5 young attached. Mr. Hays did not collect all the remaining members of the colony, but he assured the writer that, so far as he could observe, *all* the females had given birth to their young up to June 5.

A record of almost simultaneous parturiation in a colony of bats was observed by the writer in 1936 (Jour. Mamm., vol. 18, p. 97, 1936) in a colony of *Eptesicus f. fuscus* in which 11 females gave birth to young within 30 hours. In the present case the time of parturiation of six females of the colony seems to have extended over a period of not more than 48 hours centered around June 6. The condition of the embryos of the females dissected, would indicate that all of their embryos were very nearly the same age. The report of Mr. Hooper (*loc. cit.*) would indicate a similar condition in the colony he reported on.

The size of the young reported by Mr. Hooper would seem to show that they were at least two weeks old—which would mean birth on or about May 15. The birth of young in this colony, June 5–6, would put them 3 weeks later than the Alabama colony. This is interesting in that the latitude of Auburn and Robeline are nearly the same. It may be that the cold, late spring of this year might be responsible for the late parturiation.

The young grow rapidly, some better than others. At birth there is a great uniformity of weight varying only between 1.4 grams to 1.6 grams of the three born in captivity and 1.6 to 1.8 grams of the five young brought in by Mr. Hays on June 8, which could hardly have been more than two to three days old at the most. On June 19, these same young varied in weight from 2.0 grams to 2.5 grams each. This is probably not as rapid as might be expected in the wild, for it has been noticed that the mothers do not

nurse as well in captivity as wild mothers when first brought into the laboratory.

In captivity, in a colony, when the young no longer stay with the mothers during feeding periods, the young are not particular as to which mother they nurse. Neither are the mothers particular as to which young nurses them. Any young may nurse any mother. It may even go to a non-lactating female, but she will after a while get rid of it.

Of the 9 young procured this spring, there were 6 males and 3 females. This sex ratio seems to be in accordance with other reports, and also the ratio in other species of bats.

The weight of 6 adult females after nearly two weeks of nursing averaged 8.5 grams. The weight of the two females just prior to parturiation was 11.6 grams each. The average weight of non-pregnant females, 9 individuals captured in the fall of last year, was 10.4 grams.

The ratio of young at birth to adult weight is extremely high. In the present instance, the average weight of the two females, just prior to parturiation, compared to the combined average, estimated (one young partly eaten) weight of the four young that they produced would give 11.7 to 3.0 or a percentage ratio of 25.6 per cent. Compared to the average ratio of young to mother at birth, among mammals in general, this is very high. If we were to use the nursing weight of the females, this would be 35.3 per cent, an extremely high ratio.

The young will remain with the mother for not over 10 days, after which the mother will leave them when foraging for food. Up to this time the combined weight of two young carried by the female in flight in the wild will equal almost half her own weight. It seems incredible that a female is capable of carrying this weight and maneuver in the air sufficient to capture food. The author is therefore inclined to believe that in the wild the young are left at home much earlier than under captive conditions.

This report furnishes evidence similar to that reported for *Eptesius*, namely, that all females (evening bat, *Nycticeius humeralis*), in any one colony apparently ovulate in the spring within a relatively few days or perhaps hours of each other, and this is brought about by a series of environmental conditions, probably temperature. It is hardly conceivable that copulation and consequent fertilization could take place with an entire colony within such a short space of time. The more plausible explanation would be that copulation occurred some time previous and that sperm were stored in the oviducts of the females capable of fertilizing ova on release from the ovary.

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NOTES ON WINTER FORAGING HABITS OF ANTELOPES IN OKLAHOMA

By Charles H. Rouse

Although the Wichita Mountains Wildlife Refuge in southwestern Oklahoma lies within the original range of the antelope (*Antilocapra americana americana*), efforts to reestablish the species on this area have not been entirely successful. Several years ago a herd of about 35 antelopes was developed by hand raising in a small enclosure. When released on a larger pasture, however, they soon died. The most recent effort, which shows promise of being successful, was made by the Biological Survey in March 1938. Twelve adults, including 4 males and 8 females obtained from the State of New Mexico, were released in a 4,720-acre pasture on the refuge. Losses have occurred, but these have been offset by the natural increase and at the time of these observations the herd consisted of 1 adult male, 6 adult females, 1 yearling female and 5 fawns, a total of 13. An effort is being made to discover and overcome the adverse factors affecting antelopes on this refuge.

In the fall of 1939 interior fences were removed, allowing the antelopes free access to an area of about 31,000 acres. This part of the refuge is of rather low relief, the elevations being between 1,600 and 2,400 feet above sea level. The low, but rough and rocky, hills support stands of scrubby blackjack oaks (*Quercus marilandica*) and juniper (*Juniperus virginiana*), with open-grassland prairies in between. The better forage-producing areas have been depleted by overgrazing in past years and at the present time are fully utilized by buffaloes, elk, and long-horned cattle. The antelopes, either from choice or necessity, seek the higher open ridges and slopes, rarely visiting the lower grasslands for any appreciable time.

Observations of their forage habits and preferences have been interfered with by the presence of elk and deer on the same range, making uncertain the determination of plant species used. On December 25, 1939, there was a fall of some 3 inches of light snow, which remained on the ground for about 4 days, facilitating the tracking of antelopes and aiding in the determination of the plants upon which they were foraging.

The accompanying map (fig. 1), based on aerial photographs, shows the route of travel followed by the antelopes and also the relationship of their bed grounds and foraging areas to the vegetative types. The animals were sighted at point C in the afternoon of December 26 and backtracked to points B and A. On the following days their trail was followed as shown on the map.

Antelopes seem to be rather dainty foragers, rarely nosing the snow from more than a square foot of ground in any place. No evidence of pawing was found, possibly because the loose snow made it unnecessary. Small,

shrublike perennials or half-shrubs appeared to be favored as forage, although some grasses and other weeds as well as juniper and oak leaves also were taken. Snow was evidently eaten in lieu of water, as the animals visited

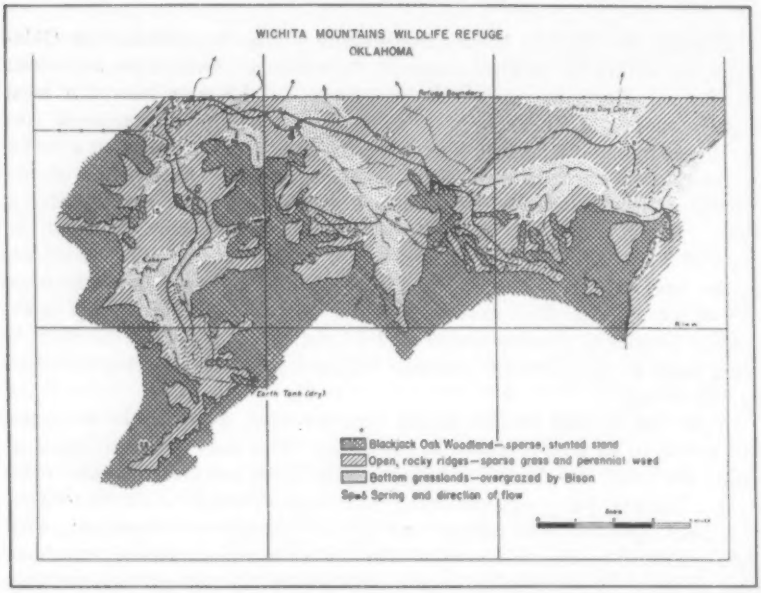
WICHITA MOUNTAINS WILDLIFE REFUGE
OKLAHOMA
Prairie Dog Colony
Earth Tank (dry)
Blackjack Oak Woodland—sparse, stunted stand
Open, rocky ridges—sparse grass and perennial weed
Bottom grasslands—overgrazed by Bison
Spwb Spring and direction of flow

FIG. 1. Travels of antelope herd from December 26 to 29, 1939, as shown by tracks in snow (Beginning at A on Medicine Bluff Creek)

A	Forage area—Dec. 26	H	Forage area—Dec. 27
B	Bedground—Dec. 26	I	Forage area—Dec. 27
C	Forage area—Dec. 26 (Herd here at 4:30 p.m.)	J	Bedground—Dec. 27
		K	Forage area—Dec. 28
D	Bedground—Dec. 26—night	L	Forage area—Dec. 28
E	Bedground—Dec. 26—night	M	Forage area—Dec. 28
F	Watered at spring—Dec. 27	N	Forage area—Dec. 28
G	Forage area—Dec. 27 (Herd seen here by Drummond in afternoon)	O	Forage area—Dec. 28 and 29
		P	Bedground—Dec. 28

a spring only on December 27. Following is a list of plants eaten by the antelopes during this period:

Scutellaria resinosa (resinous skullcap). Retains many of its leaves and some of them remain green well into the winter. The leaves and the upper parts of stems of this plant were more frequently taken than were those of any other species noted.

Chrysopsis stenophylla (stiff-leaved golden aster). Grows on dry rocky sites asso-

ciated with *Scutellaria* and was found to be frequently eaten. The seed heads, leaves, and upper parts of stems were taken.

Houstonia angustifolia (narrow-leaved Houstonia). Retains many green leaves and these as well as the stems were eaten. This species, with the two preceding, seemed to make up the greater part of the forage at this period.

Paronychia jamesii (James' whitlow-wort). Grows on drier sites in association with the above species. It was grazed on a few occasions but does not appear to be a very important forage species at this season.

Aster ericoides (white heath aster). Often found grazed, the seed heads and twig tips being taken.

Laciniaria punctata (dotted button snake-root). Grows rather abundantly in this area but was grazed in only one place. It apparently is not very palatable to antelopes.

Quercus marilandica (blackjack oak). At several places, especially on the high ridge at point M, antelopes had eaten the persistent leaves of this oak, which is also the source of important winter forage for deer in this region.

Juniperus virginiana (juniper). In several instances antelope tracks led to a dwarfed and stunted juniper of bushy habit, and each time, close examination disclosed, many twig tips had been recently broken off. Bits of foliage were also scattered on the snow about the base of the tree. Juniper seems highly palatable to antelopes as winter forage.

Cephalanthus occidentalis (buttonbush). Evidence was found at point N that antelopes had eaten persistent leaves and twig tips of buttonbush. This shrub grows abundantly along the stream courses, but it appears only moderately acceptable to antelopes as winter forage.

Baptisia vespertina (false indigo). When this plant dies it retains many of its leaves, even after being blown about by the wind. Deer frequently eat these dead leaves and on several occasions it was plain that antelopes had eaten the leaves from plants that the wind had lodged at the base of a juniper or among rocks. It is questionable how much nutritive value is retained in the leaves, but they appear definitely to make up a part of the winter forage of both antelopes and deer.

Ambrosia sp. (ragweed). This plant grows abundantly in overgrazed areas, and in a few places antelopes had eaten some of the dried leaves. It is probably unimportant, however, as forage for antelopes at this season.

Chloris verticillata (windmill grass). Places were noted where the snow had been brushed aside and this grass closely cropped. While grasses do not seem to make up a very great part of the forage of antelopes at this season, this species appears to be one of the most favored.

Bouteloua gracilis (blue grama). Grama was noted to have been often grazed and this species appears to be palatable to antelopes, as well as to bison, elk, and deer.

Panicum sp. (panic grass). Some of the panicums retain green leaves throughout winter. On a few occasions it appeared that antelopes had sought out the green leaves.

Andropogon scoparius (little bluestem). This is one of the most abundant grasses on the dry ridges and it was plainly indicated that antelopes had eaten some of the rather coarse, tough leaves. Present evidence does not indicate, however, that this is very important as winter forage for antelopes.

SUMMARY

Snow facilitated tracking of a band of 13 antelopes in the Wichita Mountains Wildlife Refuge in southwestern Oklahoma from December 26 to 29, 1939, and aided in learning what plants had been eaten by the animals.

Shrublike perennials or half shrubs made up the greater part of their for-

age, although 15 species of plants, including weeds, grasses, and shrubs were grazed.

The antelopes remained in the open, frequenting the higher, rocky ridges and rarely going near woodlands. Their bed grounds were most frequently on slopes or ridge tops. They visited a spring once during a 4-day period, apparently eating snow for water at other times.

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OCCURRENCE OF THE MANATEE IN THE UNITED STATES, WITH RECORDS FROM TEXAS

By Gordon Gunter

The range of the American manatee is generally given as the coasts of southern Florida, the West Indies and Tropical America. The manatee also occurs sporadically, and possibly was more abundant in former years, along the Gulf Coast of the United States (Brown, 1878, and True, 1884). Actual records from this region are almost nil and it was deemed worthwhile to bring the available information together.

According to Hatt (1934), all manatees in the United States and Gulf of Mexico belong to the subspecies *Trichechus manatus latirostris* (Harlan), as differentiated from the West Indian *Trichechus manatus manatus* Linnaeus.

Manatees are still present in some numbers in southern Florida. Brimley (1931) records the capture of a specimen from Masonboro Sound, near Wilmington, North Carolina. Presumably then, the animal may also occur, at least sporadically, in Georgia and South Carolina. True (1884) gives notes of Silas Stearns, of Pensacola, stating that he had seen a manatee in Santa Rosa Sound, 20 miles east of that town. Stearns relates further that old settlers said manatees were occasionally seen "twenty years ago in all inland waters from Key West westward to civilization at Pensacola, Mobile and New Orleans." He says it is evident that manatees were formerly abundant along the entire Gulf Coast and probably on the Atlantic Coast, as far north as the Carolinas, for their bones can be found along the shore nearly everywhere "that civilization has not reached." Just how creditable these observations are is not known. Apparently, they are not true for Louisiana and Texas. E. A. McIlhenny, of Avery Island, Louisiana, who has had long experience with animal life and conservation there, says he has never heard of a manatee being in the State. Dr. Remington Kellogg has kindly informed me that the U. S. National Museum has a skull, No. 257406, that was, according to their information, found at Calcasieu Lake, Louisiana, January, 1929, by Stanley C. Arthur. This is the only Louisiana

record known. The writer has not tried to obtain information from Mississippi and Alabama.

No indications have been found that manatees have ever been anything other than extremely rare in Texas, with some exception for the southern tip of the coast. The first record noted was that mentioned by True (*op. cit.*), who stated that a skull received from Texas by the U. S. National Museum in 1855 belonged to the South American species, *Trichechus inunguis*. Dr. Kellogg has kindly searched the old catalogs of the museum and has supplied me with the following information on one entry, which doubtless concerns the specimen to which True had reference: "No. 1375. *Trichechus latirostris*; Brazos, Texas; Dr. Luis Berlandiere collection (of Matamoros, Tamaulipas, Mex.) obtained by Lieut. D. N. Couch, USA.; skull and skeleton belong to *latirostris* and not to the South American *inunguis*." The Berlandiere collection was received in Washington in 1853 and was catalogued in 1855. The locality referred to was almost beyond doubt the region of Brazos Island and Brazos Santiago Pass, at the southern tip of Texas, near Matamoros, and not the Brazos River, 300 miles or so to the northeast. Also in the Berlandiere collection was a specimen (No. 2050, USNM), for which the locality given was Matamoros, Tamaulipas, Mexico. If this record can be taken literally, then the animal must have been taken in the Rio Grande and can be accredited to Texas as well as Mexico. Unfortunately, the skeleton cannot be found.

During July, 1911, a manatee was captured in the Laguna Madre, near Port Isabel, Texas, by fishermen, who found the animal entangled in their seine near the lighthouse. An account of the capture was given in a Brownsville newspaper for July 22, 1911. This animal was seen alive in New Orleans in February, 1912, by the late Arthur H. Howell, who gave this information at the request of Dr. W. B. Davis. Notes on this specimen, furnished by Dr. Remington Kellogg, say: it was captured in about four feet of water; was a male, fifteen feet and three inches long; width of tail three feet and one-half inches; length of flipper seventeen inches; color above almost black, underparts dark gray; had hardly any hair except about the nose; said to weigh 1,310 pounds; said to consume 60 to 100 pounds of grass, lettuce, etc. daily; said to have been purchased by the New York Marine Zoo. The subsequent history of this animal has not been traced.

H. C. Blanchard, of the Association of Audubon Societies, of Brownsville, Texas, told the writer that two or three years after the 1911 capture, he saw two manatees in the Rio Grande, about two miles above the mouth. He stated further that there were reports of manatees in the river for five or six years after that. C. M. Kenedy, of the Game, Fish and Oyster Commission, at Port Isabel, Texas, has written me that two manatees were caught in the Laguna Madre at different times in or about 1911. They were placed in tanks made for them and put on exhibition. Similar information comes

from C. E. Sapp, of Sabine Pass, Texas, who has informed me that three different manatees were captured (to his certain knowledge) in the Laguna Madre in the summer of 1912 and one of them was shipped to Houston for exhibition. The animals were taken in drag seines by fishermen. He says further that it was not uncommon to see manatees in the Laguna Madre during the summer of 1912. Mr. Kenedy states that before jetty work was done on the passes that he saw several manatees around them, but has seen none in recent years.

The Director of the Field Museum of Natural History has written me that a specimen which died in July, 1913, came to the museum from the Riverview Exposition Company of Chicago. This source told the museum authorities that the animal was from Texas. Considering the rarity of captive manatees and the fact that it was against the law to take them in Florida, then it seems quite probable that the Field Museum manatee is a Laguna Madre specimen. This is the skull examined by Hatt (*op. cit.*) who referred to it as being from Texas (?).

During the month of July, 1928, a dead manatee washed ashore in Copano Bay, near the town of Bayside, Texas. Parts of the skeleton were saved by Ben Earp, who recently called the matter to my attention and presented me with the parts. This locality is 125 miles north of the lower Laguna Madre.

In 1937, according to Mr. Sapp, a dead manatee floated ashore in Cow Bayou, which empties into Sabine Lake. It was mistaken for some sort of fabulous sea monster, until properly identified. An account of this animal was written up in the Port Arthur News. This account was not seen by the writer and the exact date has not been ascertained. This is the most easterly known report as well as most recent one from Texas. The location is only a few miles from the Louisiana line.

According to Mr. Earp, the Copano Bay manatee was a male and measured ten feet and four inches in length. It was decaying and the skin was sloughing off. Judging from pictures taken at the time, it must have weighed well over a thousand pounds. Barrett (1935) estimated the weight of a specimen nine feet and two inches in length at close to a thousand pounds. A fisherman from the Mission River, near Bayside, reported frightening some large water animal, over a period of a few years, when he visited his boats at night. He never saw it, but surmised later that it must have been the manatee, instead of a large alligator, as he had at first supposed.

The existing skeletal parts of the Copano Bay manatee are: the skull, the scapulae, one rib and a piece of another, and the left flipper with all of the lower skin attached. This incomplete skeleton is, so far as is known, the second indubitable Texas specimen extant. There is a complete skeleton in the Department of Zoology of The University of Texas. Its origin is unknown.

The skull of the Copano manatee measures 37.8 centimeters in length,

from the tip of the premaxillaries to the base of the occipital condyles. Three teeth are present in the left upper jaw. No other teeth are present, except five or six that had not burst the gums. In manatees the teeth normally move forward as the front ones wear away and fall out. The anterior tooth cavities were filling in with bone. Apparently, there were normally five teeth in each jaw, of which the most posterior one would not have been far enough out for the best use. The dental trough separates from the jaws posteriorly. It is covered over entirely and projects backward as a hollow, compressed, fingerlike process, containing the preformed teeth. Hatt (*op. cit.*) says that the supposed Texas specimen he examined is different from all other manatees, in that the lamina lying medial to the dental trough has expanded, so as to mask the dental wrapper completely from behind. He raised the question of whether this was a geographical or individual variation. In the present specimen a medial lamina partially, but not completely, covers the backward projection of the dental trough; so I assume that this specimen is, in that respect, unlike the one described by Hatt.

Dr. Hatt stated that the geographical representatives of *manatus* (he was referring here to the subspecies of *T. manatus*) show no constant peculiarities of the scapulae. He gave a diagram of the generalized shapes of the scapulae of the three American and one African species he recognizes. It is useless to attempt a detailed description of the present specimen without comparison with others, but the scapulae are quite different from the diagrams given by Hatt.

It is well-known that the skeleton of the Sirenia is heavy and massive. Flower, writing in the Encyclopaedia Britannica, says this is especially true of the skull and ribs. Kingsley (1888) says the manatee possesses a skeleton more dense than that of any other mammal. One of the ribs of the Copano Bay animal has been sawed through, both crosswise and lengthwise. Except for a tiny lengthwise perforation, the bone is as solid as a piece of ivory. Solid bone is said not to be so strong and efficient as the lighter, hollow bone. A water animal, which, so far as is known never comes ashore, does not need an extra strong skeleton. The manatee often feeds submerged and presumably stationary. Parker (1922) observed adults which stayed under water twelve minutes. A heavy skeleton may be of use in enabling the manatee to sink with a large load of air. Nevertheless, this situation presents a seeming anomaly. Where do the red blood cells form in this animal which, due to its mode of life, possibly has need of a greater supply than the ordinary mammal? On the other hand, because of its susceptibility to cold, the manatee may be suspected of having a low metabolic rate and possibly does not require a large supply of hemoglobin.

Manatees are very shy. Barrett (*op. cit.*) says they are probably more widely distributed than is realized. In former years manatees were more numerous in their present recognized haunts than today, and probably species pressure caused many to migrate to the northern shores of the Gulf

of Mexico. I am inclined, however, to believe that they were never present in numbers along this coast. It should be held in mind that the lower Laguna Madre, where manatees were apparently present in some numbers in former years, is as far south as Miami, Florida. This region is part of the western shore of the Gulf of Mexico and not the northern shore. It is well-known that manatees are very susceptible to cold. Cold snaps sometimes kill them in southern Florida. Cahn (1940) has given an account of such a happening during the past winter. Brimley (*op. cit.*) says the recent North Carolina specimen died in November, in the first cold spell following its capture. The extremely severe cold wave of the past winter (January, 1940), probably would have killed any manatee on the northern Gulf Coast. I have given an account of its effect on other marine animals in Texas (Gunter, in press). It is significant that no dead manatees were reported. Sharp cold waves hit the northern Gulf Coast every ten or fifteen years and it is my belief that they act as a definite barrier to the northern extension of the range of the manatee.

According to H. C. Blanchard, manatees are not numerous on the Mexican Gulf Coast north of Tampico. It is believed that the uncommon Texas manatees are strays from Mexico, although conceivably they could come from Florida; for there are some reasons, possibly not fully creditable, for suspecting that they can cover great distances. True (1884), in his historical account, mentions the case of a manatee that washed ashore dead on the Shetland Islands 155 years ago. It was supposed that the animal was carried across the ocean by the Gulf Stream and that it had probably "set sail" from the Florida Coast.

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A COMPARISON OF THE SKULLS AND TEETH OF THE TWO SPECIES OF HEMICENTETES

By P. M. Butler

The two species of zalambdodont insectivore, *Hemicentetes nigriceps* and *H. semispinosus* (=*H. variegatus* and *H. madagascariensis*) are confined to Madagascar, and resemble each other in so many respects that they must be regarded as comparatively recent differentiations out of a common ancestral stock. The adult animals are of the same size in both species, and have a similar series of black stripes down the body; but the markings are slightly less clear in *H. semispinosus*, and the light parts of the fur are whitish in *H. nigriceps* and chestnut-brown in *H. semispinosus*. In both species many of the hairs have been converted into spines; but this has happened to a greater degree in *H. semispinosus* than in *H. nigriceps*.

In a biological experiment it is often necessary to have a "control," i.e. a standard animal which has not undergone the special treatment of the experimental animal, but which in other respects is kept in the same conditions. Any differences between the control and the experimental animal must be due to the special conditions imposed on the experimental animal alone. In the study of natural changes such as those of evolution it is not possible to use this method, but a modification of it is sometimes available. The two species of *Hemicentetes* have been exposed to the same general environment (it is not known how far they fill different niches within their environment), and a comparison of the two animals should reveal differences of a relatively simple nature. We do not know the causes that have produced these differences; but I hope to show that each difference can with some plausibility be explained as a change that might be due to a single genetic factor. The differences in the skulls and dentitions, for instance, may be reduced to two such changes: (1) in the size of the teeth and (2) in the position of the teeth in relation to the skull; all other differences between the two skulls may be regarded as consequential on these. Whether this hypothesis is correct or not, it is impossible to say; I put it forward merely because it explains the facts in a simple manner.

The material studied consisted of fifteen specimens of *H. semispinosus* and twelve of *H. nigriceps*. Most of these were obtained from the British Museum, by very kind permission of Mr. Morrison-Scott. Professor D. M. S. Watson kindly loaned me some specimens of his own and allowed me to examine the material in the Zoological Museum at University College, London.

THE SKULL-PROPORTIONS

As in mammals generally, the skull of *Hemicentetes* changes in shape as the size of the animal increases. Simple indices therefore do not provide an

exact basis of comparison. If however a double logarithmic plot is made, using any pair of measurements, the points fall along a straight line (Huxley, 1932). If two groups of specimens are identical in form, and two measurements (a and b) are made on each specimen, then when log(a) is plotted against log(b) all the points, of both groups, should lie on a single straight line, although the index a/b may vary considerably. This was tested in the case of the two species of *Hemicentetes*; several measurements were made on each skull (fig. 1) with a pair of dividers, and double logarithmic plots were

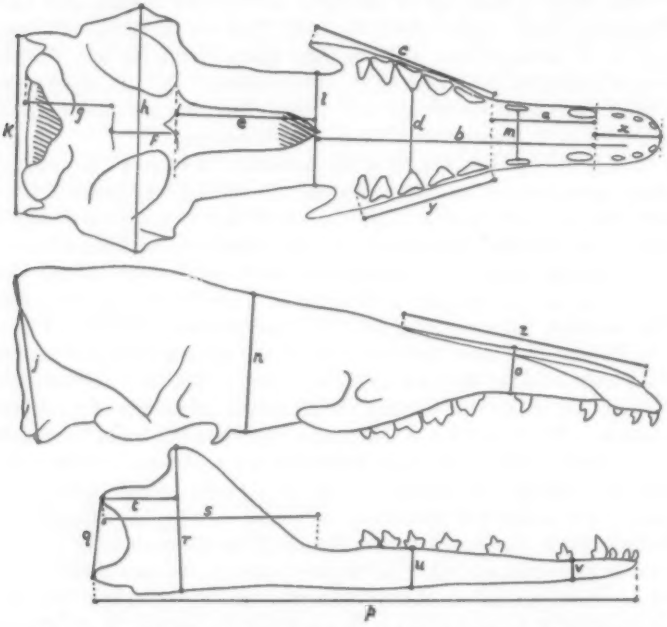

FIG. 1. Distribution of measurements made on skulls of *Hemicentetes*

made, taking as the abscissa the distance from the anterior end of the upper canine to the posterior end of the palate. When this was done it was found that, as far as most of the measurements were concerned, the skulls of the two species were identical (fig. 2).

In some measurements, however, a difference between the two species was detected. Although in each species the points lay on a straight line, the lines for the two species did not coincide, but appeared to be parallel. Thus in the equation $y = bx^k$, k seemed to be the same in both species, but there was a difference in the value of b (fig. 3). The measurements in which this was

noticed were: the width of the palate between p^2; the width of the palate between m^1; the length of the premaxilla; the height of the snout at the posterior end of p^2; the length of the middle of the skull, from the posterior end of the palate to the posterior end of the basisphenoid; the maximum height of the middle of the skull; the distance from the glenoid process to the angular process; the vertical height of the tip of the coronoid process above the lower border of the mandible; the horizontal distance from the tip of the coronoid to the glenoid process; the depth of the mandible below m_1; and the depth of the mandible just anterior to p_2.

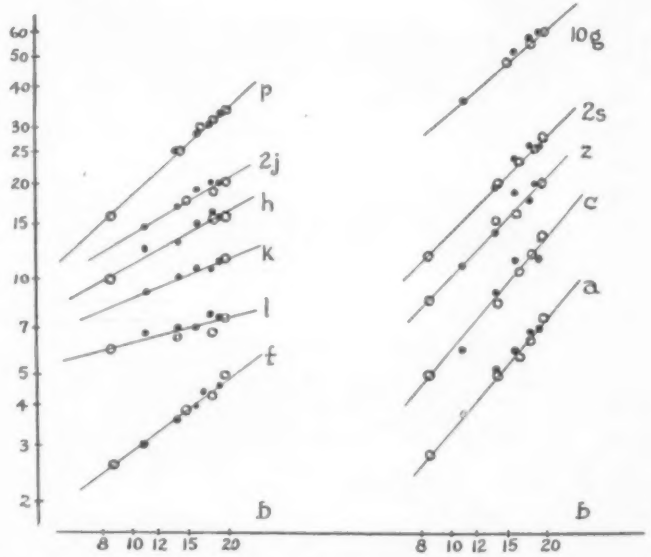

FIG. 2. Double logarithmic plot of measurements against the measurement *b*

Except for the length of the middle of the skull, all these measurements were greater in *H. nigriceps* than in *H. semispinosus*, for specimens of the same size, i.e. the constant b was greater in *H. nigriceps*.

A careful comparison of specimens belonging to the two species revealed a number of other differences. In *H. semisphinosus*, the teeth are smaller and the jaws are more slender; the tooth-rows in the molar region are less divergent; the zygomatic processes are longer and more slender, and project less strongly from the sides of the skull; the frontal profile of the skull is more concave; the anterior edge of the coronoid process is less vertical; the teeth are placed further forward relative to the beginning of the coronoid process and the anterior edge of the subtemporal fossa; the sagittal crest is less

prominent; the nuchal crest is also less prominent and projects less markedly backwards, so that the posterior face of the skull is more vertical (plate 1).

When these differences are analysed they may be reduced to the following five. In *H. semispinosus:* (a) the middle part of the skull is longer and lower; (b) the alveolar processes of the maxilla, premaxilla and mandible are reduced, and the palate is narrower; (c) the teeth are much smaller and more spaced; this applies to the canine and incisors as well as the molars, and to both jaws; (d) the temporal muscles are weaker; the sagittal and

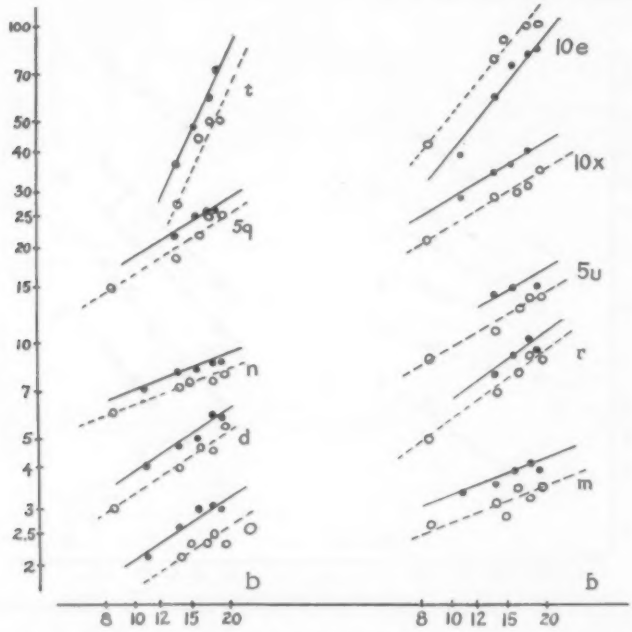

FIG. 3. As fig. 2. Measurements which are not identical in the two species

nuchal crests are weaker, the coronoid process is weaker, and the zygomatic processes are less divergent; (e) the teeth are placed farther forward on the skull.

The differences tabulated as (b) and (d) may with some reason be regarded as direct consequences of (c), the smaller size of the teeth. The relation between the alveolar processes and the teeth of mammals is very close: they develop together, and if the teeth are removed the alveolar processes also disappear. The smaller teeth of *H. semispinosus*, with their smaller roots, would naturally be correlated with a reduced growth of the alveolar proc-

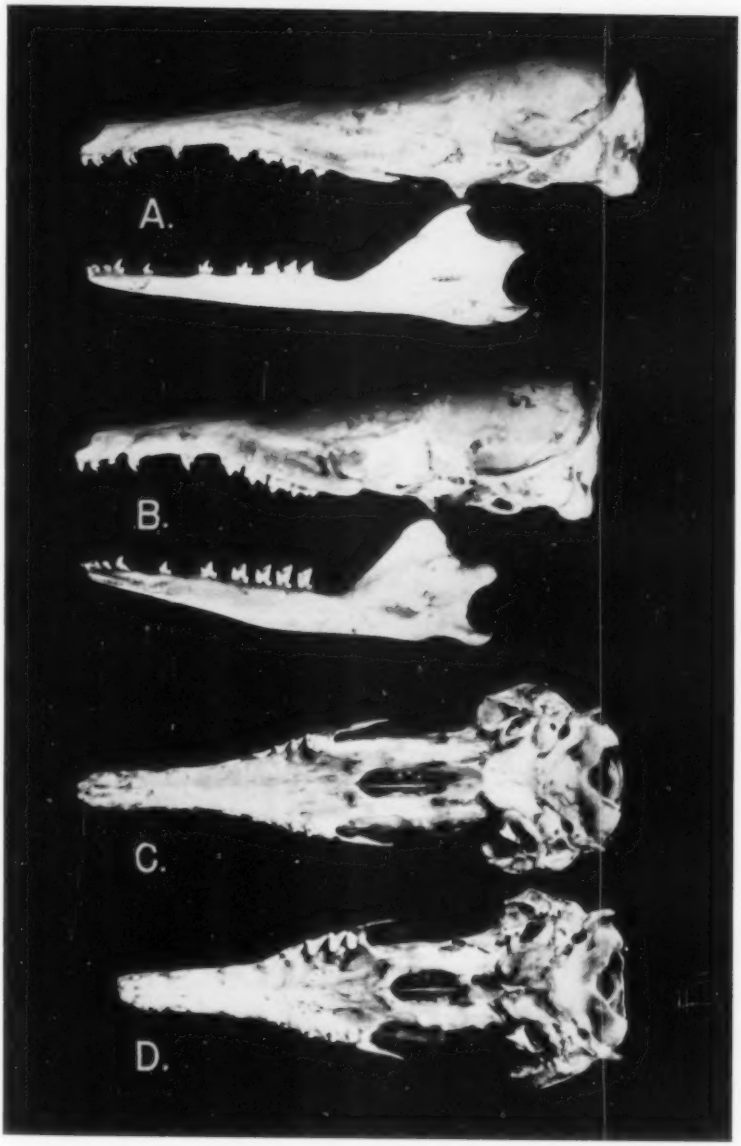

PLATE I. Adult skulls of *Hemicentetes nigriceps* (B, D) and *H. semispinosus* (A, C). (A, B) side views; (C, D) palatal views.

All measurements were plotted against the longitudinal distance from the anterior edge of the upper canine to the posterior end of the palate. For this length k was taken as 1.00. In this way it is easy to see which lengths on the skull grow most rapidly, which grow most slowly, and so on. The results obtained are as follows:—

	k
Longitudinal measurements:	
Anterior end of canine—posterior end of palate	1.00
" " " " —the point where the palate begins to broaden.	1.04
Posterior end of erupted tooth-row—the point where the palate begins to broaden	0.61
Tip of zygomatic process—the point where the palate begins to broaden	1.24
End of palate—anterior end of basisphenoid	1.27
Length of basisphenoid	0.58
Posterior end of basisphenoid—posterior edge of occipital condyle	0.87
Length of premaxilla	0.60
Length of nasal	0.92
Length of lower jaw	0.90
Condyle of lower jaw—anterior end of coronoid process	1.02
" " " " —tip of coronoid process	2.30
Transverse measurements:	
Width of palate between p^3	0.35
Width of palate between m^1	0.71
Width of skull at level of post. end of palate	0.27
Maximum width of posterior part of skull	0.54
Distance between paroccipital processes	0.38
Vertical measurements:	
Height of snout at the posterior end of p^3	0.75
Maximum height of middle of skull	0.34
Lower edge of occipital condyle to end of sagittal crest	0.58
Depth of lower jaw at anterior end of p_3	0.58
" " " " " m_1	0.61
Tip of coronoid process—lower edge of jaw	0.74
Condyle of lower jaw—tip of angular process	0.65

The distribution of these measurements is shown in figure 5.

It will be seen that the most rapidly increasing measurements are all longitudinal, so that the skull grows in length more rapidly than in height or breadth. The longitudinal growth is slower in the premaxilla, the basisphenoid, and the region of the cheek-teeth. The molar region of the palate increases in width more rapidly than any other part of the skull. The vertical growth is also slow; the posterior end of the lower jaw seems to increase in height more rapidly than any other part of the skull.

THE ERUPTION OF THE TEETH

The youngest skull of *H. semispinosus* has a lower jaw 16 mm long. In this specimen, m^2 is still imbedded in the jaw, and even the first molars are

not completely in place. In a specimen with a lower jaw of 25 mm the second molars are completely erupted, and the third molars are in process of eruption. When the lower jaw is 30 mm long m^3 is nearly erupted and m_3 nearly so, and the replacing premolars and canine are in process of eruption. There seems to be some variation in the time of development of the replacing teeth, as in some specimens with lower jaws 29 or 30 mm long the permanent teeth are all in place. The largest animal in the collection has a lower jaw 34 mm long, so that replacement of the milk teeth occurs only when the animal is nearly full-grown.

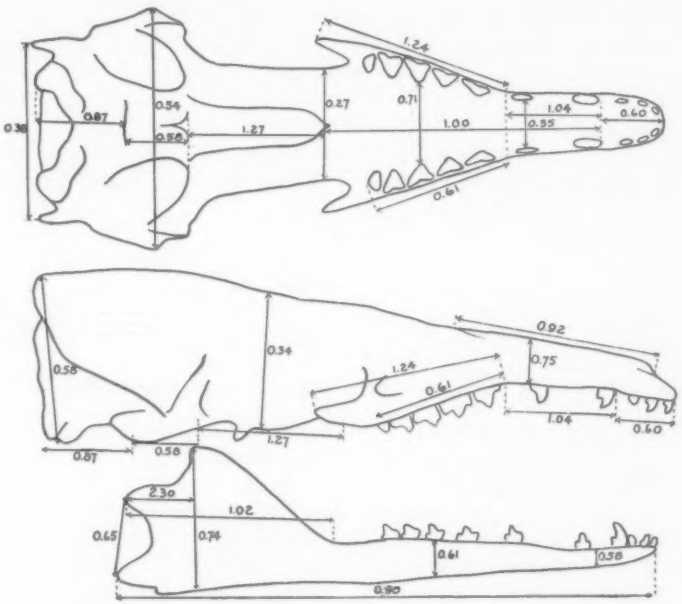

FIG. 5. Distribution of relative growth rates in the skull of *Hemicentetes*

The data for *H. nigriceps* are less complete. In a specimen of which the length of the lower jaw should be about 20 mm (calculated from the other skull measurements), m^1 is completely erupted and m^2 partly so. In a specimen in which the lower jaw is 25 mm long, the second molars are nearly erupted and the third molars are beginning to erupt; this corresponds exactly to a specimen of *H. semispinosus* of the same jaw-length. Another specimen, with a lower jaw of 29 mm, has a complete permanent dentition. The time of eruption of the teeth therefore appears to be the same in the two species.

It is interesting to note that eruption of the teeth does not seem to disturb

the development of the skull. The measurements of the palate and jaws seem to increase continuously throughout life, and there is no evident change in the relative growth-rate, even of the tooth-row. The data, however, do not permit of a rigid proof of this because of the small number of young specimens and the difficulty of determining the length of the tooth-row when the posterior teeth are incompletely erupted. As far as the data go, the eruption of the teeth seems to be part of the normal process of growth of the skull.

THE SHAPE OF THE UPPER CHEEK-TEETH

Only the outlines of the teeth were studied. An epidiascope was used. The skulls were orientated by means of plasticine in such a way that the palates were horizontal, and the teeth were focused onto a screen where they could be drawn. A ruler placed at the same level as the teeth enabled the degree of magnification to be determined.

The teeth are three-lobed or roughly triangular; there is a root to each lobe, and the principal cusp on the crown is placed above the lingual lobe. For

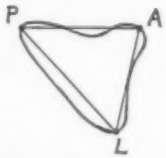

FIG. 6. Illustrating method of measurement of outlines of upper cheek teeth

purposes of measurement points were chosen at the extremities of the lobes, and were joined by straight lines to form a triangle APL (fig. 6). The lines AL and PL, and the angle ALP, were measured.

The teeth of *H. semispinosus* are about 30 per cent smaller than those of *H. negriceps* in length and breadth. The reduction in height is greater, and so the height-length ratio is smaller in *H. semispinosus* than in *H. nigriceps*. The anterior teeth, and those of both jaws, have been affected.

Within each species the teeth are very variable in form. If the ratio AL/PL is plotted against the angle ALP, the triangular shape of each tooth is represented by a point, and if all the teeth of the same sort are plotted in this way they are found to occupy an oval region on the graph (fig. 7). Adjacent teeth of course differ in form, and occupy different but adjacent regions on the graph; the ranges of variation of adjacent teeth overlap in some cases. The whole dentition forms a continuous curved band when represented in this way (AL/PL plotted against <ALP), and the teeth can be regarded as occupying varying positions on the band.

Some of the teeth used in constructing figure 7 were milk molars, but it was found that the range of variation of the milk molars and corresponding

premolars is only slightly different, if indeed the small number of specimens justifies the assumption that there is any difference at all. The two classes of teeth were therefore studied together.

In the anterior part of the series of cheek teeth the ratio of the two edges is relatively constant, decreasing very slowly as the teeth are traced backwards; the angle, however, is rapidly reduced. Towards the posterior end of the series the angle is reduced less rapidly, and the ratio is increased.

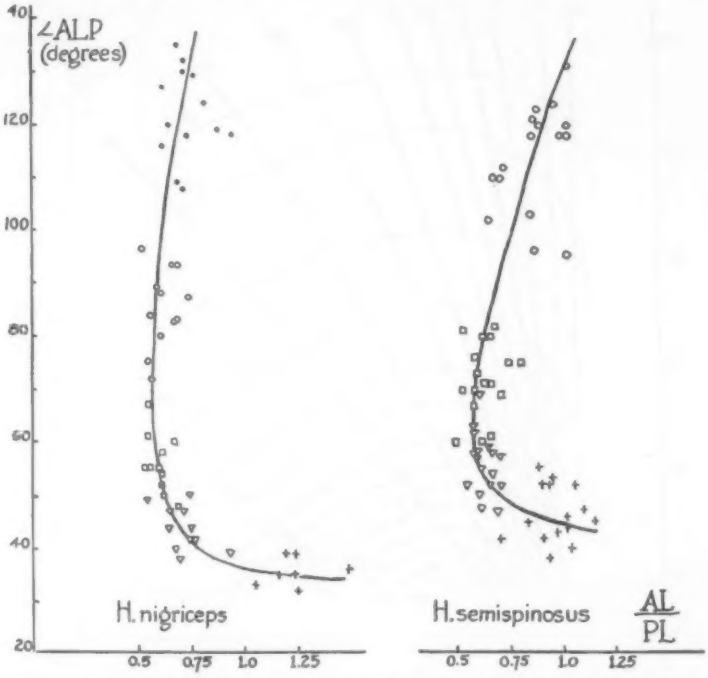

FIG. 7. Outlines of upper cheek teeth. The ratio AL/PL is plotted against the lingual angle ALP. Key: ● p^3 and pd^3, ○ p^4 and pd^4, □ m^1, ▽ m^2, + m^3.

As the outlines of the upper cheek teeth can be regarded as consisting of three lobes, it seemed to be of interest to find the relation between the relative sizes of the three lobes and the position of the teeth on the AL/PL: ALP graph. This was done approximately in the following way:—Imagine that the three lobes grow outwards from a point I and that each lobe is nearly symmetrical (fig. 8). The tips of the lobes form a triangle APL, of which I is approximately the incenter. Assuming that I is accurately the incenter,

it is possible to determine graphically the relative lengths of the three lobes, IA, IP, and IL, for a triangle of any given shape. From the figures obtained the ratios $\frac{IL}{IA + IP}$, $\frac{IP}{IA + IL}$ and $\frac{IA}{IP + IL}$ were calculated, giving the growth along the axis of each lobe in relation to the growth along the other two lobes.

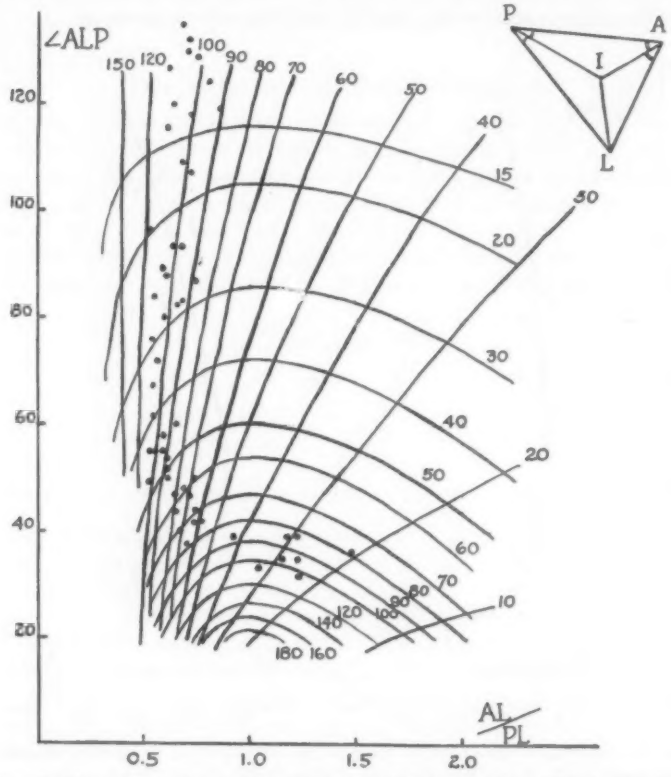

FIG. 8. Lines of equal percentage growth of lingual radius (IL) (approximately horizontal set of lines), and of posterobuccal radius (IP) (approximately vertical set of lines). The points marked represent teeth of *H. nigriceps*.

In this way it was possible to construct the diagram given in figure 8, from which the relative growth of the lingual lobe and of the posterobuccal lobe can be read off if the shape of the tooth is known.

If this diagram is superimposed upon the graph of figure 7 (fig. 8), it will be seen that the posterobuccal lobe is constant in p^3 and p^4, and first begins

to be reduced in m^1, the reduction becoming much more marked in m^2 and m^3. The lingual lobe is increased throughout, but tends to increase less rapidly towards the posterior end.

The view that the cheek teeth form part of a system is borne out by other ways of plotting the data. Thus if the anterior edge (AL) is plotted against the angle ALP (fig. 9) the teeth are found to lie on a continuous band, the anterior edge becoming gradually longer as the angle is reduced. A similar

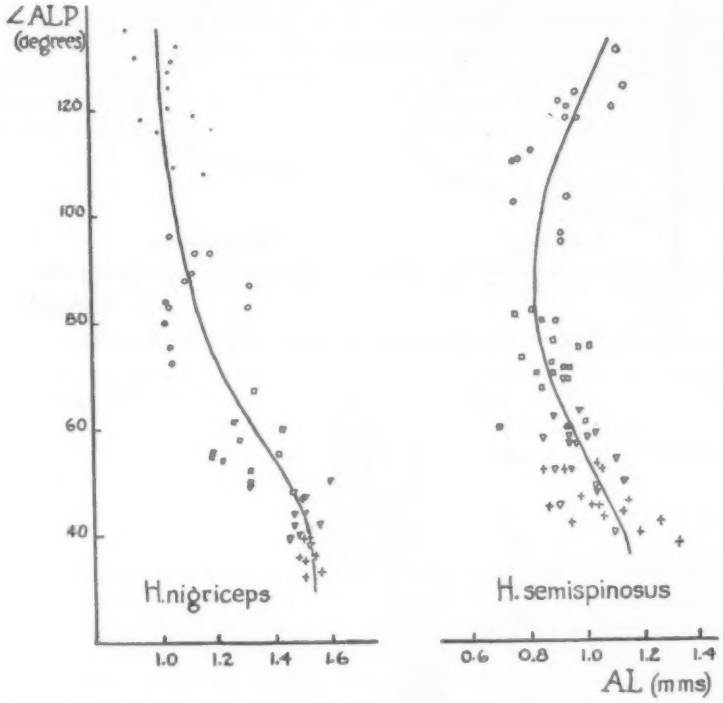

FIG. 9. Anterior edge of tooth plotted against lingual angle. Key as in fig. 7

result is obtained if the posterior edge is plotted in the same way (fig. 10), except that this edge reaches a maximum in m^1 or m^2, when the angle is about 50 degrees, and is rapidly reduced in m^3. In both these graphs the ranges of variation are shown to be considerable, and there is a tendency for the ranges of adjacent teeth to approach each other or actually to overlap.

A comparison of the cheek-teeth of *H. semispinosus* with those of *H. nigriceps* shows, as has already been noticed when discussing the skulls, that each

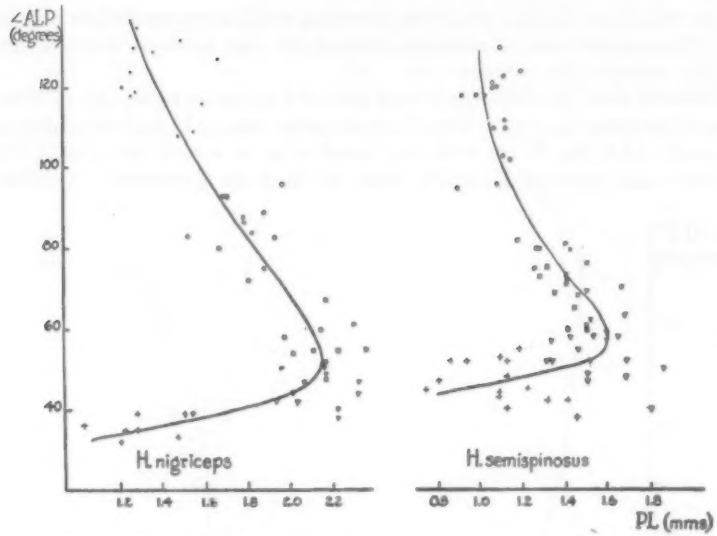

FIG. 10. Posterior edge plotted against lingual angle. Key as in fig. 7

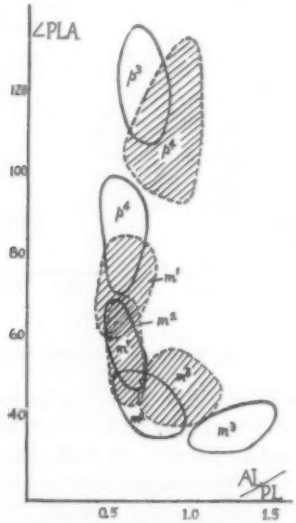

FIG. 11. Superposition of ranges of variation of cheek teeth of *H. nigriceps* and *H. semispinosus* (shaded). Plotted as in fig. 7.

tooth of *H. semispinosus* resembles more or less closely the tooth of *H. nigriceps* that stands one place further forward: p^4 of *H. semispinosus* resembles p^3 of *H. nigriceps*, m^1 of *H. semispinosus* approaches p^4 of *H. nigriceps*, and so on. This is illustrated in figure 11, where the ranges of variation are shown. It will be seen that, on the average, p^4 of *H. semispinosus* has nearly the same form as p^3 of *H. nigriceps* except that it is sometimes a little closer to p^4 of *H. nigriceps*, m^1 of *H. semispinosus* is intermediate between p^4 and m^1 of *H. nigriceps*, m^2 of *H. semispinosus* overlaps with part of m^1 and m^2 of *H. nigriceps*, and m^3 of *H. semispinosus* is intermediate between m^2 and m^3 of *H. nigriceps*. The sequence of patterns seems to have been shifted backwards in *H. semispinosus* by a little less than one tooth. The cheek dentition as a whole has a different relation to the skull in the two species, and its differentiation appears to be directly related to its position in the skull. If it is assumed (Butler, 1939) that the cheek teeth form a morphological unit controlled by a limited number of organizing factors, it would seem probable that the organizing centers have the same relation to the skull in both species, but a different relation to the teeth.

There are certain differences that cannot be explained in this way. In *H. semispinosus* p^4 has on the average a slightly longer posterobuccal lobe than p^3 of *H. nigriceps*, and so does not fit exactly into the same series. M^3 is also not exactly intermediate between m^2 and m^3 of *H. nigriceps*, as its posterobuccal lobe points directly backwards instead of partly buccally, and the lingual angle is therefore greater than in the related species. These small divergences are probably due to small peculiarities of the local environment in which the teeth develop. How far these peculiarities are caused by independent genetic factors is of course unknown.

CONCLUSIONS

The experimental study of development has as its final object the elucidation of causal processes which produce an adult body from a fertilized egg cell of a given genetic constitution. Two principal methods have been used. One is the method of disturbing normal development in various ways, e.g. by grafting or removing organs, or by subjecting the animal to abnormal environmental conditions, or by injecting chemical substances into it. The other is the method of comparing the development of animals of different but similar genetic constitutions.

Comparative anatomy is concerned primarily with the phylogenetic meaning of the differences between species. If evolution is to be explained in terms of genetics, the differences between two species must be due primarily to genetic differences which have caused the members of the two species to develop in a different manner. In this way the morphological analysis of specific differences leads on directly to problems of genetics.

The relation between gene and character is, however, a complex one: between them lies a complex process of development. An organism is a unified whole whose parts interact upon each other throughout development. In a group of adult animals it is frequently possible to find correlations which indicate causal relationships during development. The parallel variation of a number of teeth, for instance, suggests that the teeth have been influenced by the same morphogenetic factor. The present study suggests that a careful comparison of closely related species might be of value in showing how morphological characters are related to each other, and would thus suggest problems to be investigated by experimental means.

It is assumed that the two species compared are too closely related to differ in a very large number of genes, and that the characters by which they may be distinguished must be reducible to a small number of basic differences. This is a bare assumption, and not until many other pairs of mammalian species have been compared in a similar way, or until breeding experiments have been carried out, will it be possible to consider the results obtained as more than tentative suggestions.

The comparison suggests that there is a very close causal interdependence between the teeth and the skull. The reduction of the teeth in *H. semispinosus* is accompanied by a number of changes in the skull which can be compared with those produced in dogs when the teeth are artificially removed. Reduction of the size of the teeth has occurred in other groups of mammals, and it would be of interest to determine whether similar changes in the form of the skull always occur. There is also a relation between the differentiation of the dentition and the position of the tooth row in the skull, suggesting that the form of a tooth is causally determined by an "organizer" in a relatively fixed part of the head.

The unity of the dentition, at least of the cheek dentition, is borne out by this study. The alternative hypothesis, that each tooth is independently controlled by a number of genes, which have all changed together in the transition from one species to the other, seems too complicated to be probable. The supposition that the cheek-teeth vary as a single morphological unit is much simpler.

SUMMARY

1. *Hemicentetes semispinosus* and *H. nigriceps* resemble each other in pattern, size, and geographical distribution (probably). They are also very similar in most of their skull proportions.

2. They differ in the size of their teeth, those of *H. semispinosus* being about 30 per cent smaller than those of *H. nigriceps*. Probably correlated with this are a number of differences in skull proportions: the alveolar processes of the jaws are reduced, the palate is narrower, the parts of the skull related to the temporal muscles are weaker, and the middle of the skull is longer and lower.

3. The tooth rows lie further forward in the skull of *H. semispinosus*. Each tooth of this species approaches in form the tooth situated one place further forward in *H. nigriceps*.

4. When plotted so as to show their shape (anterior edge/posterior edge plotted against lingual angle), the cheek-teeth lie on a continuous band. The teeth of both species lie on nearly the same band.

6. The milk teeth of *Hemicentetes* closely resemble the permanent teeth. In both species they are replaced only when the adult body-size has been almost attained.

7. The relative growth of parts of the skull was determined. The skull grows in length more rapidly than in height or breadth.

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A COLLECTION OF MAMMALS FROM DONDI, ANGOLA

BY JOHN ERIC HILL

With field notes by the Reverend Kenneth H. Prior

In 1932 when Kenneth H. Prior was preparing to leave the University of California for Dondi, Angola, to take up work at the Currie Institute, operated jointly by the United Church of Canada and the American Congregational Church, arrangements were made to save for the California Museum of Vertebrate Zoology a representative collection of the small mammals from the area of Dondi. The collection provides important new information about the geographic distribution of several species, adds to our knowledge of geographic variation in others and provides new information otherwise, as set forth below.

In all there are 159 specimens of 23 species. The collecting was done by native students, who supplied also the information for the field notes. The specimens are well prepared, their condition reflecting favorably on the students and their teacher.

Dondi, 3 mi. NE Bêla Vista, latitude approximately 12° 30′ S, longitude 16° 15′ E, elevation 5600 feet, is situated in the interior plateau of Angola,

inland from the coastal mountains. The climate is temperate. Rolling plains extend to the east and south with scattered wooded areas and individual trees. The stream sides are usually wooded; the rivers form part of the Cuanza drainage system. The dry season usually begins in May and lasts through September. The rains begin in October and reach a maximum in December. The total rainfall is approximately 1500 millimeters. The faunal relationships of this area are predominantly with the Rhodesian Highland District of the East and South African Subregion (Chapin, J. P., 1932, p. 90).

I am indebted to Dr. H. E. Anthony, Curator of the Department of Mammalogy, The American Museum of Natural History, for permission to work on this collection and to use comparative material in his charge, and to Dr. E. Raymond Hall of the Museum of Vertebrate Zoology, University of California, for placing at my disposal the material herein reported upon, and for other assistance.

Crocidura bicolor bicolor Bocage. Pygmy white-toothed shrew.—Ouimbundu name, "Okonyunga"; 1 specimen.

Nasilio brachyrhyncha brachyura Bocage. Jumping shrew.—Ouimbundu names, "Songanga, Sakunganga, Sakutopi"; 2 specimens.

Field notes.—"Lives in a burrow, but not of his own digging. . . ; makes a series of very small cleared paths through the bush. The young are born on the bare earth [of the burrow] about April."

These jumping shrews were taken about 150 miles north of the type locality, but they agree closely with the original description.

Epomops dobsonii Bocage. Epaulette bat.—Ouimbundu name, "Elima"; 1 specimen, June 30.

Field notes.—"Seen mostly in the wet season. . . , give birth to two young which cling to the mother's teats even when she flies. . . ."

This specimen is almost intermediate in color between a richly colored series taken in March and two faded ones taken in August (American Museum).

Galago senegalensis moholi A. Smith. Bushbaby.—Ouimbundu name, "Onono"; 11 specimens, June to November.

Field notes.—"They live in holes in trees . . . and in bee hives. . . . They give birth to two young. . . . Nest lined with leaves and grass."

The young have blackish tails. One old male has much more fawn overlay than any of the others, and there is some variation in the tone and amount of the yellowish wash on the hind legs.

Galerella sanguinea bocagei Thomas and Wroughton. Little mongoose.—Ouimbundu names, "Evili, Okavili"; 3 specimens.

Field notes.—"They give birth to two young. . . . Taken in the woods."

One of the specimens is much less reddish than any in the collection of the American Museum from Angola, almost as dark as *Galerella sanguinea ibeae* from Kenya.

Paracynictis selousi de Winton. Selous' Mierkat.—Ouimbundu name, "Ekêlê"; 3 specimens.

Field notes.—"Found in holes in the ground or caves. . . . They eat grasshoppers and carrion. . . . They give birth to two young." This last statement is confirmed by a female containing two fetuses seen by D. G. Lancaster (Shortridge, 1934, vol. 1, p. 140). The mammae in the adult female, taken December 6, were active and consisted

of two abdominal pairs; three pairs (one pectoral) had been reported as the normal number.

Angola specimens of *Paracynictis* are slightly darker than topotypical *P. selousi* with which they were compared, and have more blackish on legs and arms. The auditory bullae are more inflated. There is considerable variation, however, in both series.

Poecilogale albinucha Gray. Striped weasel.—Ouimbundu names, "Okahandambela, Okalukandambela"; 3 specimens, August 10.

Field notes.—"Lives in small caves . . . or rat burrows. . . . Very brave. . . . Gives birth to two young." Shortridge (1934, vol. 1, p. 203) writes that two fetuses were found in one specimen collected by Lancaster. This confirms the notes of the present collector. The female has two pairs of mammae on the lower abdomen situated close together (in the dried skin the pairs are separated by about 15 mm.).

Poecilogale is widely distributed but usually rare. Several races have been described, but these are of doubtful validity, being based on inadequate material.

Pedetes cafer angolae Hinton. Springhaas.—Ouimbundu name, "Ohuiyu"; 5 specimens.

Field notes.—"Live in bush and plains . . . in burrows. They give birth to two young. Their gait is [saltatorial] and zigzag. . . , they are difficult to catch." Shortridge (1934, vol. 1, p. 317), says that twins are rare, and gives evidence from several authors of a single fetus in more than five hundred females examined.

The female taken July 15 was suckling young; the mammae, two pairs, are pectoral.

Claviglis kelleni Reuvens (?). Small dormouse.—Ouimbundu name, "Ochisesele"; 1 specimen, June 25.

Field notes.—"Live in old beehives . . . or in holes in trees. . . . Nest of leaves and grass. . . ; give birth to two young."

This dormouse appears to be much like *Claviglis kelleni*, which came from southern Angola. It is smaller and darker than the nearby *C. ansorgei cuanzensis*, and has a blackish pedal mark. The skull is shorter than that of *cuanzensis* of the same age, the rostrum especially, also the bullae are decidedly smaller. The tail is darker than that of *kelleni*, and the specimen possibly represents an undescribed race.

Tatera valida Bocage. Large gerbil.—Ouimbundu names, "Ohulu, Epeke, Okalela." (The last two names are probably chiefly used for a smaller species, not included in this collection.) Bocage (1890, p. 7) says the natives at Cuando call *T. valida*, "Canguella"; those at Caconda, "Hûlo or Ohûlo". The last is very similar to the Ouimbundu name; 17 specimens.

Field notes.—"Chiefly on the plains or in abandoned fields, but some may be found by the rivers. . . . They give birth to about five young in April." This estimate is perhaps too large and the date of birth too restricted. Females taken in June and August were lactating and showed mammae in four pairs, two pectoral and two inguinal.

The groove in the upper incisor is slightly more shallow in the Dondi specimens than in a series from Chitau.

Tatera humpatensis Hill and Carter. Brown-bellied gerbil.—not distinguished by the natives from the preceding species; 2 specimens, July 27 and 31.

One specimen showed four pairs of mammae, arranged as in *Tatera valida*, the other had the more usual three pairs, one pectoral and two inguinal.

The occurrence of this species so far north as Dondi was quite unexpected. Both specimens have white-tipped tails, a character that occurs in about half the Humpata series. The hind feet, except for the whitish toes, are nearly the color of the back. Cranially the Dondi specimens agree closely with paratypical specimens of the same age.

Leggada bella sybilla Thomas. Dwarf or pygmy mouse.—Ouimbundu name, "Ondoti, Okandoti, Kandondo"; 1 specimen, July 1.

Field notes.—". . . found in the woods. . . . Children can catch them [by hand]. . . . They give birth to three or four young."

This specimen shows, as usual in the species, five pairs of mammae, three pectoral and two inguinal.

Mastomys coucha A. Smith. Hut mouse, multimammate rat.—Ouimbundu name, "Ombandu." 43 specimens.

Field notes.—". . . found in the woods and in houses . . . by rivers . . . and in the fields."

Mastomys is an extremely widespread rodent, being common wherever human habitation occurs in Africa, exclusive of the Egyptian district.

Rattus rattus Linnaeus. Black and roof rats.—Ouimbundu names, "Epengue, Ekolongongo"; 20 specimens.

Several varieties of black and roof rats are found in Angola. One specimen, in the brown phase, has pure white underparts; most individuals have plumbeous underparts, and one is somewhat intermediate in this character.

Aethomys thomasi de Winton. Bush rat.—Ouimbundu name, "Ekolongonjo"; 5 specimens, June–August.

Field notes.—"Rat of the ant-hills." All were secured in the woods, according to the collector.

G. M. Allen in his "Checklist of African Mammals" places *Mus thomasi* de Winton in the genus *Dasymys*. I examined the skull of the type in London and found it to agree much more closely with *Aethomys*, particularly with *A. walambae*.

In two lactating females the mammae are two pairs inguinal; no pectoral mammae could be found. The usual number in this genus is three pairs, one of which is pectoral.

Aethomys avunculus avunculus Thomas. Bush rat.—Not distinguished by natives from the preceding species; 1 specimen, November.

This specimen agrees quite well in color and in cranial characters with *A. a. avunculus*, but it is appreciably larger than any specimen examined and its first upper molar has only four roots, instead of the usual five, a variation known to occur in *Aethomys*.

Dasymys nudipes Peters. Angola water-rat.—Ouimbundu names, "Ochifele, Ocifele"; 3 specimens; June 24, 25, July 1.

Field notes.—"River rats. Their burrows leave the bank of the river and run uphill. When you dig for them they run into the water. . . ; to catch them plug up the hole in the river bank and dig from above, and pour water into the plugged hole. . . . They give birth to two young, April–May." The female taken June 24 was lactating, with two pairs of inguinal mammae. This number does not agree with previous accounts of this species. Probably mammary formulae are subject to some variation in most species.

Rhabdomys pumilio angolae Wroughton. Four-striped mouse.—Ouimbundu names, "Ongenge, Ongemba."

The 13 specimens agree closely in coloration with a small series from Namba and Monte Victoria Verdun in the American Museum; specimens from Chitau, to the northeast, are slightly darker. A specimen taken June 30 is renewing its pelage, the worn hairs on the rump and sides being much more ochraceous than the fresh ones on the back.

The mammae were active in June and July specimens; there are four pairs, two pectoral and two inguinal.

Pelomys frater Thomas. Creek rat.—Ouimbundu names, "Eyunju, Ocifele, Ochifele." The last names are used primarily for *Dasymys*; 5 specimens, July, August.

Field notes.—"Found in burrows by the river. . . ; gives birth to two or three young, about April. . . , eats grass. . . ."

These specimens are brighter than February and March specimens from Chitau and Namba.

Lemniscomys griselda griselda Thomas. Single-striped grass rat.—Ouimbundu names, "Ohuakua, Ongela"; 2 specimens, one subadult, June 22, 23.

Field notes.—"Found in woods, on plains and by rivers. They . . . make nests . . . in thick grass. To get away from grass fires they go into holes and burrows [of other species]. They give birth to two, three or four young in April and May." The number of young given here agrees with East African species of *Lemniscomys* previously reported (Hollister, 1919, p. 144), but there is probably less restriction to the time at which young are born than the collector's note indicates.

Dendromus (Poemys) nigrifrons angolensis Roberts. One-striped mouse.—Ouimbundu name, "Kotetele"; 1 specimen, June 15.

Field note.—"Abandoned field."

The single specimen agrees well with a large series from Chitau in the American Museum; the black frontal marking is absent, as in most individuals of this race.

Cryptomys mechowii Peters. Large mole-rat.—Ouimbundu name, "Ohui"; 5 specimens, June–October.

Field notes.—"Lives in [a complicated] burrow-system. . . . When rains are heavy the *Ohui* goes to a central chamber, or burrows on lower levels. . . . It eats [various tubers] and . . . roots. One or two young are born in January or February. The nest is built of chewed roots mixed with grass. They occur in pairs, male and female." The statements regarding time of birth and the occurrence of pairs, except for a limited period, require definite confirmation.

The coloration varies considerably without regard to sex, age, or season, but the five specimens can be matched in the large series from Chitau in the American Museum.

Cryptomys bocagei de Winton. Little mole-rat.—Ouimbundu name, "Onete"; 9 specimens.

Field notes.—"These resemble greatly the *Ohui* in habits, food, etc. . . . They give birth to 2 or 3 young. Up to ten may be [dug out of] . . . one system of burrows." Each of two lactating females has three pairs of mammae, two pectoral and one inguinal.

This species varies in color from grayer than cinnamon to near blackish plumbeous, lightly overlaid with a buffy brown.

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GENERAL NOTES

EASTERN MOLE IN SOUTH CAROLINA

A small series of moles taken by myself near Caesar's Head, South Carolina, at an altitude of approximately 3000 feet, during June and July, 1938 and 1939, have been identified by Dr. H. H. T. Jackson of the Biological Survey as *Scalopus aquaticus aquaticus* (Linnaeus). Dr. Jackson points out that the series is not typical but is more nearly *aquaticus* than *howelli*. This identification adds a new form to the faunal list of South Carolina.—ROBERT H. COLEMAN, *Route 4, Box 212, Charleston, S. C.*

COYOTE VERSUS PECCARY

We are indebted to Charles S. Blanchard, government predatory animal trapper of Arizona, for the following sidelight of unusual interest on the coyote versus javelina subject.

Last March, while trapping coyotes in the vicinity of Benson and Mescal, Arizona, Mr. Blanchard noted where a group of javelinas, having come upon a coyote in one of his traps, killed the predator and tore up the carcass. This attack occurred at a time when natural javelina foods were available.—CHARLES C. SPERRY, *U. S. Fish and Wildlife Service, Denver, Colorado.*

THE FOX SQUIRREL IN IDAHO

The occurrence of the fox squirrel in Idaho should be reported as an addition to W. B. Davis' lists in "The recent mammals of Idaho" (1939). Two specimens from Boise, collected by Dr. L. E. Hicks and the writer on July 16, 1939, and now at the Ohio Cooperative Research Unit, Columbus, Ohio, were determined as "intermediate between *Sciurus niger rufiventris* and *S. n. neglectus*, nearer the former" by the late A. H. Howell, of the Fish and Wildlife Service. (Letter to L. E. Hicks, September 12, 1939.)

Undoubtedly the fox squirrels have been transplanted to this State. It has not been possible to ascertain accurately the date of this planting, though it is certain that some squirrels from the Middle West were released in Boise in 1917 and the planting was considered a failure. The effective establishment of the species must have been after that year. Six animals were trapped in Boise in 1936 and sent to Lewiston, Idaho, where the species has become abundant.

Fox squirrels have been observed at the eastern edge of Boise and 4 miles to the east on the Boise River bottoms. Their suitable habitat is not more than 2 miles wide; thus it covers about 8 square miles. In 83 city blocks of the residential district there were 41 groups of two to three leaf nests indicating probably a pair of animals to every other block. On this basis there are approximately 700 squirrels in the city proper. In the writer's opinion another 300 are to be found in the outlying districts but within the limits of their range, making an estimated population of slightly more than 1,000 squirrels.

Numerous shade trees, including elms, maples, locusts, and black walnuts, provide protection and food for the squirrels much as in many middle western towns. The squirrels are free from predators, except house pets, but there are numerous losses from automobiles. Leaf nests and dens in hollow trees are used in much the same manner as is characteristic of these animals in their original range.

A comparison of the certain climatic features of Boise, Idaho, with that of Columbus, Ohio, is of interest. The accompanying graphical representation of the average monthly maximum and average monthly minimum temperatures demonstrates a close degree of similarity. A comparison of extremes in temperatures is as follows:

	Boise	*Columbus*
Absolute maximum temperature	121	106
Absolute minimum temperature	−28	−20
Average number of days with temperatures of 32 degrees or less	108	105
Average number of days with temperatures of 0 degrees or less	2	4

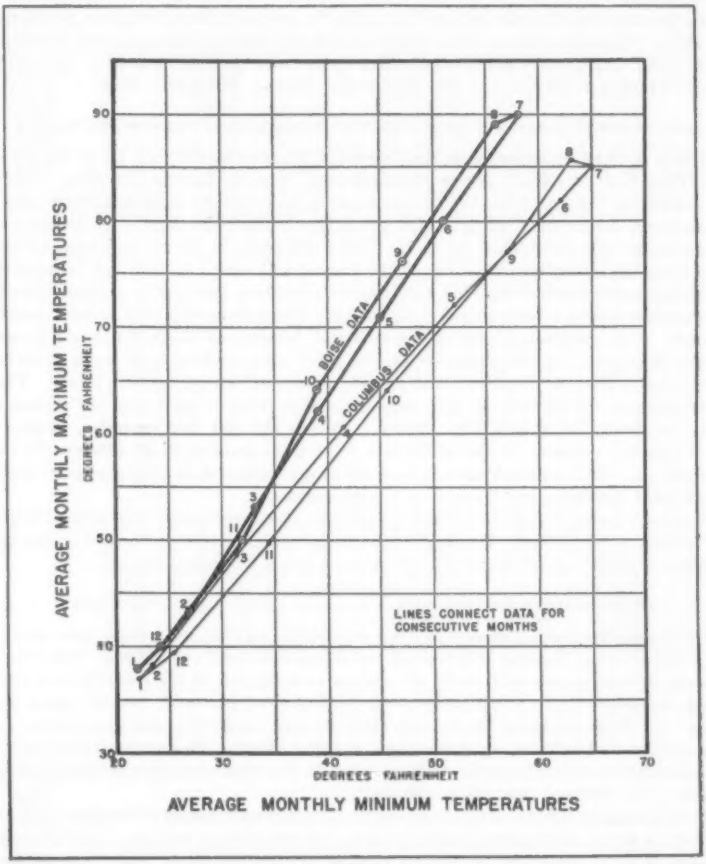

FIG. 1

The precipitation varies greatly, however. Columbus has an average rainfall of 35.77 inches a year whereas the Boise average is 13.4 inches. The range of the squirrels is restricted to the river bottoms and city where irrigation modifies plant and growth conditions greatly; so that the rainfall does not indicate the real amount of water in the area.—WILLIAM H. MARSHALL, *U. S. Fish and Wildlife Service, Boise, Idaho.*

GROUND SQUIRREL IN AN OAK SAPLING

On August 29, 1940, about eight miles east of Solon Springs, Douglas County, Wisconsin my attention was called to a thirteen-striped ground squirrel (*Citellus tridecemlineatus tridecemlineatus*) in a white oak (*Quercus alba*) sapling. The animal was about five feet from the ground and about 18 inches from the trunk. Upon seeing me it flattened itself along the limb on which it was resting and ceased moving. At my approach it leaped to the ground and ran about 12 feet to a burrow. An examination of the tree showed that the squirrel had partially severed a bunch of green acorns from its stem. On many other occasions this species was seen picking up green acorns and hazel nuts. Apparently green mast makes up no small part of its food at this time of year.—THOMAS J. MORRISSEY, *921 Mississippi Avenue, Davenport, Iowa.*

CRATOGEOMYS CASTANOPS FROM A RECENT TERRACE IN SOUTHWESTERN KANSAS

While working an exposure in Meade county, Kansas, locality no. 16, in the SW¼ of the SE¼ of S. 29, T. 33S, R. 29W, with a field party from the Kansas University Museum of Vertebrate Paleontology, the author found a fragmentary skull and lower jaws of *Cratogeomys castanops*. The specimen, no. 5970, Kansas Univ. Mus. Vert. Paleon., was found seven feet two inches above the Upper Pliocene, in an old soil zone which is nine feet nine inches below the top of the present soil zone. A thorough examination of the exposure showed that the specimen was in place and not in a recent burrow. *Cratogeomys* has not been found in any of the Pleistocene deposits of southwestern Kansas. The specimen measured, interorbital breadth of skull, 7.1 mm.; alveolar length of upper premolar-molar series, 9.6 mm.; alveolar length of lower premolar-molar series, 9.2 mm.; and width of muzzle at root of the zygoma, 10.9 mm. These measurements and all other details correspond with those of specimens of *Cratogeomys castanops* from Texas and New Mexico. During the last five summers, nearly all known gopher colonies in Meade County have been trapped in an attempt to take *Cratogeomys*. So far as is known, this is the first evidence that *Cratogeomys castanops* inhabitated southwestern Kansas in recent times.

I wish to thank Claude W. Hibbard, Assistant Curator, Kansas University Museum of Vertebrate Paleontology, for permission to report this specimen.—GEORGE C. RINKER, *Museum of Birds and Mammals, University of Kansas, Lawrence, Kansas.*

COUNTS OF EMBRYOS IN NEVADAN KANGAROO RATS (GENUS DIPODOMYS)

During the first part of each of the two years 1938 and 1939 in the Soda Lake district, Churchill County, Nevada, I examined 183 *Dipodomys ordii columbianus*, and 311 *Dipodomys merriami merriami*, as to sex and as to condition of the reproductive tracts of the females. Of *D. o. columbianus* 90 females (49.2 per cent) and 93 males were taken. Of *D. m. merriami* 141 females (45.3 per cent) and 170 males were taken. All animals obtained in February (8 *merriami*, 61 *ordii*), August (59 *merriami*) and September (11 *merriami*) were trapped. Those taken in the other months were poisoned (see Alcorn, Jour. Mamm., Vol. 21, p. 160, 1940).

In 50 pregnant females of *D. o. columbianus* the largest number of embryos in any one female was 5; the smallest number was 2; and the average was 3.6. In 32 pregnant females of *D. m. merriami* the largest number of embryos found was 4; the smallest number was 2; and the average was 3.1.

The chart (figure 1) summarizes the information about females. It indicates among other things that some females have more than one litter of young a year. This indication results from the fact that in *D. m. merriami* more than a third of all the females taken in each of the months of March, April, and May, were pregnant. The indication that there is more than one annual litter is stronger in *D. o. columbianus* because three-fourths of all females taken in February were pregnant, as were nearly a half of those

taken in March and April.—J. R. Alcorn, *California Museum of Vertebrate Zoology, Berkeley, California.*

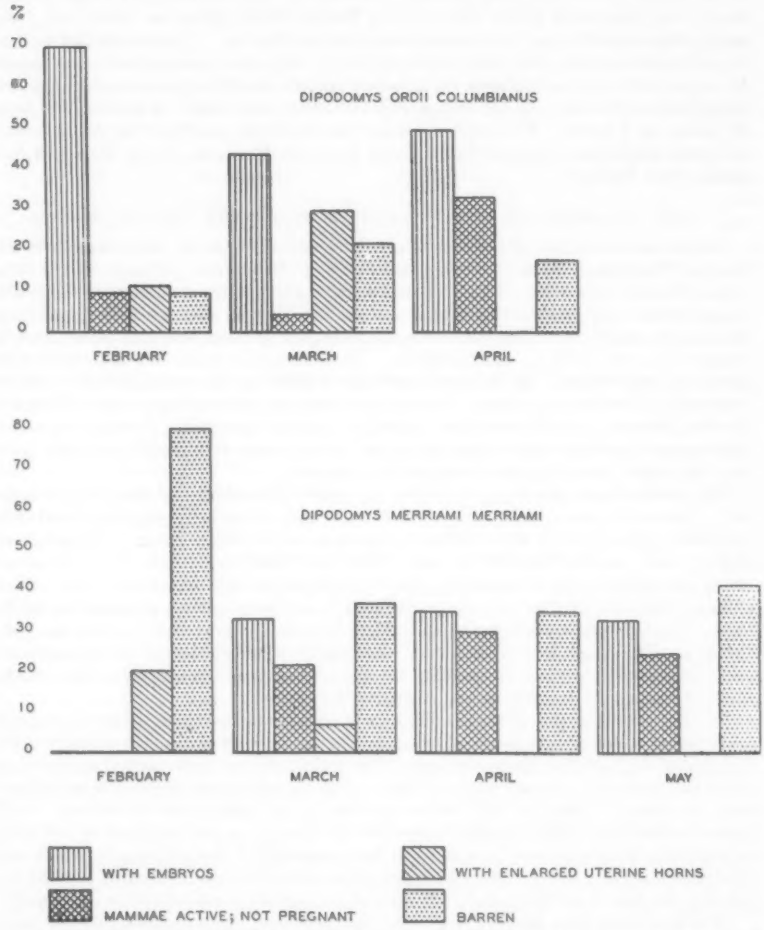

Fig. 2. The number of females of *Dipodomys ordii columbianus* examined in each month was: February, 33; March, 27; April, 30.

The number of females of *D. m. merriami* examined in each month was: February, 4; March, 67; April, 17; May, 12. Of 36 taken in August and 5 taken in September none had embryos or young.

MEASUREMENTS OF A BEAVER AT BIRTH

In the August, 1939, Journal of Mammalogy, vol. 20, p. 358, Edward R. Warren and E. Raymond Hall described a new race of beaver, *Castor canadensis concisor*, inhabiting

a range that includes Rocky Mountain National Park, Colorado. The measurements of adults of the form were given in that article, and it is believed that data on the size of the young at birth may be of interest. On June 16, 1940, the body of an adult female beaver was discovered beside the Cache la Poudre River, elevation 10,300 feet, from which protruded the head of a partly born female offspring. The parent had died of hemorrhages in labor, the young being stillborn. No other young were in the womb. Measurements of the adult were not obtained, but those of the young were as follows: length, nose to base of tail, 11¾ inches; tail, 3¾ inches; total length, 15 inches; hind foot, 2½ inches; ear ¾ inches. The entire specimen was preserved, and is now in the collection of Rocky Mountain National Park.—Fred Mallery Packard, *Rocky Mountain National Park, Colorado.*

DARK COLORATION OF SOME SPECIMENS OF PEROMYSCUS CRINITUS CRINITUS

In a recent collection of *Peromyscus crinitus crinitus* taken on lava ridges at Saint George, Washington County, Utah, about one-half of the mice are much darker than normal for the subspecies. These animals were trapped on the east slope of the Black Ridge immediately west and southwest of town as well as on a similar lava ridge about three miles southeast. They were collected from piles of black lava rock overlying soil eroded from red-tinted Navajo Sandstone. These rocks are rather heavily coated with green and gray lichens. At this altitude of about 2900 feet, the creosote bush, *Covillea tridentata*, is the dominant plant. Grasses and other annuals such as species of *Bromus*, *Triodia*, *Phacelia*, and *Nicotiana* are active for a part of the year. The mice are taken much more frequently where these plants are interspersed with small lava rocks than they are where many large boulders are piled together.

The darkest specimen in my collection (no. 1423) has underfur of deep neutral gray with a light drab subterminal band on the hairs. Many of the long overhairs have black tips which give a general effect of deep mouse gray to the dorsal stripe. The sides are slightly paler but not different in hue. There is no pectoral spot on the underparts which are neutral gray in color, the hairs lacking white tips except for a few in the axillae. The skin of the dark ears is pigmented and there are no preauricular white hairs. The chin and lower parts of the face are light neutral gray and there is a blackish eye ring. The distal part of both front and hind feet are whitish while the proximal parts are colored like the underparts of the body, the skin of the feet being pigmented. The tail is chaetura drab above and slightly paler below.

Another specimen (no. 1363) is not so dark, because of the much longer light drab subterminal bands on the hairs. The general appearance of the lateral stripe is drab and that of the dorsal stripe mouse gray. The underparts are light neutral gray with a slight indication of a darker pectoral spot. This specimen also shows a blackish eye ring. A third specimen (no. 1856) is like the first but the underparts are whitish. Still another animal (no. 1860) is similar to the first but has a large pectoral spot of buff with an extensive buffy suffusion over most of the remainder of the underparts, which are otherwise whitish. Many of the specimens have buff-colored pectoral spots, both those pale in color and those fairly dark, but none of the darkest specimens show these spots.

Of 32 specimens from the lava ridges near Saint George, 15 are distinctly darker than topotypes of *Peromyscus crinitus crinitus* from Shoshone Falls, Idaho. The remaining mice show considerable variability in pelage color but can be referred without difficulty to *crinitus*.

It is interesting to note that E. A. Goldman ("Revision of the Wood Rats of the Genus *Neotoma*" N. A. F. no. 31 U. S. Dept. Agriculture, Biol. Surv., 1910, p. 77) reported a similar tendency toward dark coloration in *Neotoma* from the lava areas at Saint George.

I wish to thank Dr. Lee R. Dice of the University of Michigan for making the color comparisons (Ridgway, 1912) as well as the California Museum of Vertebrate Zoology,

Berkeley, for the use of comparative specimens.—Ross HARDY, *Dixie Junior College, Saint George, Utah.*

THE EASTERN COTTON RAT IN VIRGINIA

A single female specimen of the eastern cotton rat (*Sigmodon hispidus hispidus*) collected in Mecklenburg County, Virginia, on August 15, 1940, and contributed to the mammal collection of the United States Fish and Wildlife Service provides a new state record for Virginia. This extends the known range for the genus north from Raleigh, North Carolina, approximately 60 miles.

I collected this specimen while I was on a three-day collecting trip along the Virginia-North Carolina line. Had it not been for extremely heavy rains causing freshets that washed away many traps, other specimens probably would have been procured. The specimen obtained was live-trapped on a typical Piedmont region knoll along Blue Creek two-tenths of a mile south of the Clarksville corporate limits between U. S. Highway 15 and the Roanoke River. The predominating herbaceous plant in the vicinity was beard grass, *Andropogon virginicus*. Other vegetation on the area included *Rubus* sp., *Desmodium* spp., *Lespedeza virginica*, *Lonicera sempervirens*, *Rhus glabra*, *Quercus* sp., *Prunus serotina*, *Symphoricarpos orbiculatus*, *Solidago* sp., *Potentilla* sp., *Smilax* sp., and *Aster* spp.

Since the occurrence of cotton rats on range inhabited by the bobwhite quail may constitute an important factor in management, a determination of the distribution of this mammal is of particular importance to the wildlife technician. Future collecting may possibly extend its known distribution farther north through the Piedmont and east through the Coastal Plain regions of Virginia.—CLYDE P. PATTON, *North Carolina Department of Conservation and Development, Division of Game and Inland Fisheries, Raleigh, North Carolina.*

ZAPUS HUDSONIUS AMERICANUS IN SOUTH CAROLINA

On June 7, 1940, near Caesar's Head, S. C., at an altitude of approximately 3000 feet, I trapped a single specimen of *Zapus hudsonius americanus* (Barton). This specimen, an adult male, number 1263 in my collection, was taken on the weedy bank of a little stream, near the edge of a small mountain meadow and within 100 yards of the boundary line between North and South Carolina.

So far as I have been able to learn this is the second record for South Carolina. Franklin Sherman records the capture by R. B. Casey of an individual of this species near Clemson College, S. C., on November 7, 1928 (Jour. Mamm., vol. 4, p. 513, November, 1937). This seems to be the first authentic record for the state.—ROBERT H. COLEMAN, *Route 4, Box 212, Charleston, S. C.*

A POCKET-GOPHER CAGE

The cage here described is the most satisfactory of several types that we have used in attempts to keep live *Geomys* in the laboratory under conditions where they can readily be observed. While we have used this only for *Geomys*, it seems probable that it may be equally satisfactory for a number of other animals.

The complete cage, as shown in the accompanying figure, is composed of 3 elements; feeding compartment, nest-box and connecting tunnel. The connecting tunnel consists of a piece of 4 inch tile drain pipe, 12 inches long. When the cage is assembled, one end of the connecting tunnel fits into a hole in the feeding compartment, the other into an opening in the nest-box. In order to make the connecting tunnel resemble the burrow by means of which a pocket gopher reaches the surface of the ground, the floor of the feeding compartment is constructed so as to be 4 inches higher than that of the nest-box. Since the opening for the reception of either end of the connecting tunnel is near the

level of the floor of each of the other two elements of the cage, the connecting tunnel slopes downward from the feeding compartment to the nest-box. Captive *Geomys* seem to appreciate this arrangement because freshly caught specimens, when placed in the feeding compartment, find the connecting tunnel and go through it to the nest-box, almost at once.

The nest-box, which is made of concrete, is rectangular in shape, except for the end with the opening for the connecting tunnel. This face is at such an angle that the connecting tunnel is at right angles to it when the cage is assembled. The inside dimensions of the nest-box are 5 by 8 inches with a vertical depth of 6 inches. The top of the nest-box is covered with a concrete lid which projects into the nest-box for a distance of 1½ inches. Since there is only 4½ inches of vertical distance in which the animal builds its nest, the nest is usually constructed with but little grass for a roof and for this reason observations can readily be made by removing the lid. Captives spend most of their time in the nest and on occasion the concrete lid has been replaced by a glass plate, which facilitates making observations without apparently annoying the captive.

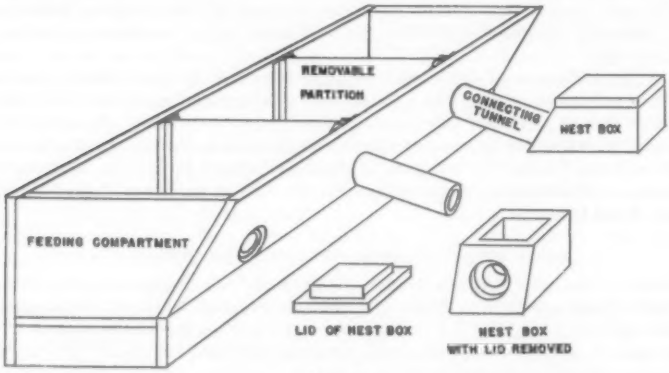

FIG. 3

This is especially true for warm weather when but relatively little nesting material is used.

For convenience, the feeding compartment is constructed so that 3 nest-boxes connect with it. Two removable partitions are provided so that the feeding compartment can be subdivided into 3 spaces of equal size, one for each of the nest-boxes. When desirable, one or both of the partitions may be removed, thus allowing the occupants of separate nests access to a single feeding compartment and the adjoining nests. The feeding compartment is constructed of boards an inch in thickness and it is lined with galvanized iron. Like the nest-box, it is rectangular in shape, except for the side towards the nest-box, which is at such an angle that the connecting tunnels come off at right angles to it. The floor of the feeding compartment is 14 inches wide by 4 feet in length and this chamber has a vertical depth of 12 inches. The top of this compartment is covered with a lid constructed of wire mesh.

When in use, the floor of the feeding compartment is covered with moist sandy soil to a depth of several inches. In dry weather, the nest-box and connecting tunnel are sprinkled with water to simulate the natural humid conditions under which *Geomys* usually live. Grass is provided for nesting material and a variety of suitable foods are

supplied. Under these conditions, and provided the cage is kept adequately clean, we have had no difficulty in keeping healthy *Geomys* in this cage for months at a time, during which interval the animals were inspected daily in their nest-boxes.—H. B. Sherman and B. A. Barrington, *Department of Biology, University of Florida, Gainesville, Florida.*

REVIEWS

Arambourg, C. Mammifères fossiles du Maroc. Mém. Soc. Sci. Nat. Maroc, Paris, no. 46, pp. 1–72, figs. 15, pls. 9. December 15, 1938.

The long-standing puzzle of the many species of pleistocene mammals described from North Africa by Pomel now appears to be cleared up in a general way. A number of forms had been identified by Arambourg (with M. Boule) several years ago, in connection with his account of the mammals of the Béni Ségoual caves in Algeria (Arch. Inst. Paléont. Hum., vol. 13, pp. 1–242, 1934). The status is now settled of the North African gnu (*Connochaetes prognu* Pomel) which belongs to the genus *Gorgon*, i.e. the *taurinus* group, and of the reedbuck (*Antilope* (*Nagor*) *maupasi* Pomel) which is regarded as a subspecies of the recent *Redunca redunca*. The characters given of a new form of eland (*Taurotragus derbyanus maroccanus*) appear insufficient to the reviewer; it would seem that the horn-cores described belong to the male of the same form of which Pomel's *procana* is the female.

The careful descriptions and comparisons of the horizons, the complete list of species, and the obvious familiarity of the author with the general conditions of the country and deposits, and with the available material, make this paper one of the most valuable contributions to our knowledge of African pleistocene mammals.—Ernst Schwarz.

Bigalke, R. Animals and Zoos Today. Cassell and Co. Ltd., London, Toronto, Melbourne and Sydney 8vo., 190 pp., illus. 1939.

Dr. Bigalke is interested not only in the problem of how zoos fit into the community and what they contribute, but also in the broader problem of how native faunas may best be preserved and studied. The book is a collection of essays on matters "directly or indirectly connected" with the National Zoological Gardens at Pretoria. The chapters on why zoos are important emphasize the fact that as yet books and pictures have not been able to supplant zoos in their primary function of helping people become acquainted with wild life, and that in this field there is much room for expansion. Exhibits of lower vertebrates and invertebrates, particularly insects, should be increased, teachers, themselves, need to learn more about the animals before guiding students around, and the addition of "technical zoologists" to staffs would permit more "investigational work." The chapters on longevity and breeding in captivity furnish many interesting statistics, and the series on camouflage, instinct, social habits, migration, and animal flight, although they do not deal particularly with African forms, give a good introduction for the layman to these matters. Especially interesting are the accounts of the dassie, and of how the scaley anteater walks, rolls up, climbs, and gets his food. Naturalization of animals and the present status of non-endemic species is discussed. Much of the rest of the book, starting with a chapter on exterminated and vanishing animals of South Africa, deals with the importance and function of game reserves. The history of Kruger National Park is outlined, and, of the 480 odd species and subspecies of birds and mammals found there, some of the more conspicuous forms, chiefly carnivores and antelopes, are selected for a brief and informative discussion of where and in what numbers they are found in the park. The good series of photographs

by Dr. Bigalke himself, Herbert Lang, Pieter Koch, and the Publicity and Travel Department of the South African Railways contributes much to the interest of the book. —Barbara Lawrence.

Cabrera, Angel, and Jose Yepes. Mamiferos Sud-Americanos (vida, costumbres y description). Buenos Aires: Compania Argentina de Editores, Soc. de Resp. Ltda. 4to., pp. 1–344, 68 pls. in color from original drawings by Carlos C. Wiedner. 1940.

This is a comprehensive account of the entire mammal fauna of South America and, even though confessedly popular, it is the first serious attempt ever made to cover this field. Aside from text books and compilations in general natural histories, no single work is available to which one may turn for information on Neotropical mammals. This production, therefore, is one of the kind that "fill a long-felt want."

The authors are experienced mammalogists of reputation and scholarship who bring to the book a guaranty of accuracy and a wealth of original information as well as a wide knowledge of contributive literature. Although they disclaim any intention of meeting the needs of special students, any professional mammalogist could scarcely fail to find their book a welcome addition to his library.

The thick volume begins with a chapter on geographic distribution and a colored map dividing South America into eleven zoogeographic districts. This may be of suggestive value to the general reader but falls short of the needs of the special student of distribution. The division lines between districts are obviously arbitrary and freely cross natural features without regard to detailed facts of distribution. The districts are not of equal importance and the genera and species mentioned in the text as characterizing them are disappointingly few and frequently of doubtful significance. The authors make some apology for this and recognize the imperfection of present knowledge, but evidently believe a defective map is better than none at all.

Following is an elaborate text in which orders, families and species are systematically treated, the matter on each being subjectively divided to cover habits, distribution, and description. In addition there is often much historical matter. Under each genus all or nearly all the important species are described. Subspecies are sometimes mentioned, but more frequently are dismissed with a statement that one or more may be recognizable. Technical names for all species are given, but without authorities or references. There are no identification keys, even for higher groups, and no text figures, since the book is obviously not a manual. An important feature is the common names which are invariably applied to all species, from native and local sources wherever possible, but perforce manufactured in many cases. Incidentally, the English speaking reader is impressed with the ease and simplicity with which the Spanish language adapts itself to the formation of vernacular group names. The groups of Primates, for example, are the Aotinos, Cebinos, Aluatinos, Atelinos, etc. Cetaceans as well as land mammals are thoroughly covered and no group is slighted, practically every recognizable genus yet discovered being included. Of necessity, a large part of the descriptions of species is compiled and thus many slightly characterized and imperfectly known forms are given a prominence probably greater than they deserve. A genus which has been recently studied naturally receives more attention than others less known. Thus, for *Marmosa*, no less than forty supposed species are described, whereas, for *Oryzomys*, only eleven are mentioned.

With a few exceptions, nomenclature is fully up to date and where there is variance from usual practice, it seems to be intentional. *Hapale*, once unsuccessfully proposed for "fiat," is used instead of *Callithrix; Eira* and *Galictis* instead of *Tayra* and *Grison;* and *Ozotoceros* instead of *Blastocerus*. Unfamiliar technical names appear here and there, the generic ones doubtless due to the senior author's announced preference for the recognition of slightly characterized groups and the specific ones to his unusual command of literature.

The sixty-eight richly colored plates are distinctly above the average for a book of this kind. The engraving and reproduction are excellent and the shortcomings of the pictures are mostly such as are inevitable unless the artist is himself a naturalist and familiar with the animals in life. The larger animals, as usual in such cases, are much better than the smaller ones and the attempt to show small mice in natural size against a background of mountains and forest is not very successful. However, many of the subjects have never been shown in color before and, even though most of them are drawn from stuffed skins, they may have their uses.

The book is concluded with an appendix on economic zoology and conservation, a glossary and a full index. A list of mammals (1) extinct, (2) nearly extinct, (3) threatened with extinction, and (4) diminishing rapidly is of considerable interest. Only two are given as wholly extinct, the Falkland Island Dog and the Chilean Chinchilla. As to the first no one doubts, but there is a bare possibility that a very few chinchillas remain. Two also are listed as on the verge, the Bolivian Chinchilla and the Pudu deer. Of these, the chinchilla is certainly very scarce, but the Pudu is far from extinction, still being fairly numerous in many parts of central and southern Chile where its habitat in dense forest probably guarantees its existence for many years. The Huemul seems to be in far greater danger than the Pudu.

As the authors themselves well recognize, the difficulties in the preparation of such a book are enormous. The imperfection of knowledge even of fairly common mammals is very great and when it is considered that collections in South American museums are quite limited, the wonder is that such a good result could be produced. Its style and form are those of an old-fashioned "natural history" and it is directed particularly to the general public, especially that of Spanish America, but it cannot fail to have a wide interest for mammalogists all over the world.—Wilfred H. Osgood.

Hamilton, W. J., Jr. American Mammals: Their Lives, Habits, and Economic Relations. McGraw-Hill Book Company, Inc. New York and London, pp. i–xii, 1–434, 92 figures (and frontispiece). Cloth, $3.75. 1939.

The author says in the preface that he "has long felt the need for a single volume which would include the characteristics and habits of North American mammals in more detail than has previously been accorded these subjects. Such a volume should presumably act as a reference text and be of more than passing interest to the layman, teacher, and professional zoologist alike."

The book now before us admirably fills this need and it will be welcomed by both laymen and professionals.

The early chapters treat of mammalian ancestry, classification, technical characters and economic uses. Then follow chapters treating more particularly of ecology and habits—adaptations, food, storage, reproduction and early life, homes, hibernation, migration, populations, behavior, and distribution. Concluding chapters discuss mammals in their relation to man—useful mammals, injurious mammals, game, fur-bearing, and predatory species.

Hamilton has evidently searched the literature of mammals assiduously and has assembled a surprising number of quotations from other authors. He has given special attention to food habits, the chapter on this subject being documented by 143 references. Incidentally, a very considerable number of references are from the Journal of Mammalogy.

Since the book is apparently intended primarily for the use of biology teachers and students, and quite likely may require future editions, it seems appropriate to point out some errors that might well be corrected.

In treating of the increase of deer on the Kaibab Plateau (p. 405), Hamilton says: "All killing of deer was prohibited and government hunters were employed to destroy predatory mammals, particularly the mountain lion and coyote. The removal of these

predators resulted in a tremendous increase in the deer herd." Stanley P. Young has pointed out (Jour. Mammalogy, vol. 21, p. 98, February, 1940) that * * * * "the Kaibab Plateau, bounded on the south by practically impassable canyons, and on the north by unsuitable semi-desert terrain, never possessed the prime requisites of a suitable refuge. And this fact, plus the lack of proper management after the discontinuance of the previously age-long hunting by Indians and white men, were two of the chief causes of the abnormal deer increase that brought nation-wide attention in 1924, after deer had been over-protected on the area for 18 years." Mr. Young further states that government hunters played only a minor part in removing predatory mammals from the Kaibab. Most of the lion hunting there was done by private parties, who employed local guides using trained hounds; one of the outstanding of these hunters was "Jimmy" Owens.

The statement (page 282), quoted from John Eric Hill, that desert pack rats "can walk on these needles (of the cholla cactus) with impunity" seems quite impossible. E. A. Goldman says that these rats do not pave their runways with "the needle-sharp spine clusters," but the runways are bordered with pieces of cactus, allowing a passageway free from spines.

On page 53, the range of pikas "from Alaska and Alberta south to Mexico" should read "to New Mexico."

Before another edition is published the author may find it desirable to revise the account of the whale fishery. Among other papers, he should consult the following:

Risting, Sigurd. 1922. Av Hvalfangstens Historie. J. W. Cappelens Forlag, Kristiania, pp. (10) plus 625 plus (5).

Harmer, Sidney F. 1928. The history of whaling. Proc. Linnean Soc. London, 140th Session, 1927–28, pp. 51–95.

Harmer, Sidney F. 1931. Southern whaling. Proc. Linnean Soc. London, 142nd Session, 1929–30, pp. 85–163.

The author is to be congratulated on presenting so comprehensive a summary of mammalian history and ecology in a book that will be extremely useful to the students of mammals and of compelling interest to the casual reader.—Arthur H. Howell.

Kuroda, Marquis Nagamichi. A Monograph of the Japanese Mammals. Tokyo and Osaka: The Sanseido Company, Ltd. 8vo., 2 + 1 + 11 + 2 + 311 pp., 48 colored pls. Cloth, 18 yens. September, 1940.

Now we have Marquis Kuroda's book on the mammals of Japan towards which he has been working for several years. It is a semi-popular book, primarily for the use of the Japanese people, and consequently is written in Japanese. English names, however, follow the scientific names heading each species or subspecies account, and references by number to the illustrations make correlation easy. Descriptions, measurements, distribution, and other notes are given in Japanese under each form. The 254 mammalian races include with the exception of the cetaceans and the sirenians all of those known from the Japanese Empire, including Korea, Formosa, and other possessions. Of these Japanese land mammals, 44 have been named as new by Kuroda himself, a number exceeded only by Oldfield Thomas with 46. Two new forms are named by Kuroda, namely, *Macaca fuscata yakui* (p. 273) and *Mus molossinus kuro* (p. 277).

Citations of literature are arranged in an appendix and grouped under numbers 1 to 254, again correlated with the numbers given the species or subspecies in the text. Special mention should be made of the excellent illustrations, all colored and representing in 331 figures in 48 plates the 254 forms of mammals, depicting by extra figures where necessary, individual or sexual color variations, or color of the young.

Even though this book for one not versed in Japanese language has possible use for identification purposes, it appears so valuable that one can but wish it was accompanied at least in part by an English translation.—Hartley H. T. Jackson.

RECENT LITERATURE

(Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters)

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ANONYMOUS. American buffalo. Wyoming Wild Life, Cheyenne, vol. 4, no. 10, pp. 6, 16. October, 1939.

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penangensis, Hylopetes sagitta sipora, Sciurus prevostii baramensis, Sciurus nigrovittatus venetus, Rattus rattus robinsoni, Rattus rattus perhentianus, Rattus rattus permanggis, Rattus mülleri credulus, Rattus sabanus dictatorius, Rattus sabanus salanga, Rattus surifer puket, Rattus surifer telibon, Rattus surifer muntia, Rattus surifer pidonis, Rattus surifer natunae, Rattus rapit cameroni, Rattus whiteheadi piratae, Rattus whiteheadi subitus, Tragulus javanicus hendersoni, Tragulus kanchil insularis, Tragulus kanchil pidonis, Tragulus kanchil pumilus.

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OBITUARY NOTICE

DANE COOLIDGE

1873–1940

Dane Coolidge, novelist and naturalist, was born at Natick, Massachusetts, March 24, 1873. He died at his home at Dwight Way End, Berkeley, California, August 8, 1940.

His early life was spent on the orange ranch of his father at Riverside, California, where he hunted and trapped in the mountains. He became known as the boy naturalist of his town and spent much of his time digging out coyote dens and robbing eagle's nests.

At the age of 21 he entered Stanford University where he later obtained a position as field collector, and collected mammals and reptiles for the University of Nevada in the summer of 1895, for the British Museum in the summer of 1896 in southern California, and for the U. S. Biological Survey in the summer of 1897.

Some years later he began collecting live animals for the Bronx Park and the National Zoological Park. For several years he ranged around through the west and made trips into Old Mexico, Arizona and Nevada. He was one of the first Americans to trap in Europe where in 1900 he collected mammals in Italy and France for the U. S. National Museum. Quoting from a letter from Mr. Coolidge, Rome, Italy, June 29, 1900, he said: "I found the Sicilians decidedly turbulent and loud-spoken, but through the recommendation of Major Howe, U. S. Consul, I got under the wing of an American Italian and so escaped all real trouble. I had enough stones heaved through my window at Palermo to suggest the reaction of the Italian mind upon scientific research."

After his return from Europe he went west and became interested in the photography of wild animals, especially desert forms. He spent years making the acquaintance and cultivating the friendship of different Indian tribes, following up round-ups and photographing cowboy life in order to procure material for his stories.

He had been in the bottom of Death Valley many times, on the Rio Grande with Texas Rangers, as far north as Wyoming, the scene of the great rustlers war, and in boom mining-camps.

Mr. Coolidge was a graduate of Stanford University and did postgraduate work at Harvard. He was a member of the Author's League of America and a charter member of the American Society of Mammalogists.

He is perhaps best known as an author, as he has published seven histories of cowboys, prospectors, fighting men and Indians, all illustrated with his own photographs. Besides he has written 35 western novels, each with a historical background, and has contributed many short stories to the Youth's Companion, Outing, Red Book and many other periodicals.—H. HAROLD SHAMEL.

COMMENT AND NEWS

TWENTY-THIRD ANNUAL MEETING

The twenty-third annual meeting of the Society will be held at the Field Museum of Natural History, Chicago, June 9–14, 1941. Details of the meeting will be mailed to all members in March, but plan now to attend.

Local Committee on Arrangements

Wilfred H. Osgood, Chairman

Tappan Gregory	Bryan Patterson
Donald M. Hatfield	Marcus Ward Lyon
Karl Schmidt	Colin C. Sanborn

DAVIS APPOINTED EDITOR

In December, Dr. William B. Davis, Professor in the Department of Fish and Game at the Agricultural and Mechanical College of Texas, College Station, was appointed chairman of the Editorial Committee by the Board of Directors to fill the vacancy left by the late Arthur H. Howell. Davis has agreed to carry on as corresponding Secretary of the Society until the next annual meeting.

RECENT LITERATURE SEPARATES

Separates of lists of Recent Literature appearing in the Journal are available through the Treasurer, Miss Viola S. Schantz, Fish and Wildlife Service, Washington, D. C., at a cost of 18 cents a number or 70 cents for the entire volume of 4 numbers.

LIBRARY SERVICE

F. N. Bassett, 722 N. Orange Drive, Los Angeles, California, has established a "Service Station" for those who are interested in securing scientific books and papers on natural history and allied subjects, such as Geology, Paleontology, Ethnology; reports, surveys, journals, memoirs, etc. Members interested in adding to their library might do well to write him.

BIOLOGICAL SURVEY COLLECTION

Some uncertainty has arisen concerning the official designation of the collections in care of the former Biological Survey since the transfer of that organization to the Department of the Interior and the creation of the Fish and Wildlife Service. By official order, now effective, the name of the Section of Wildlife Surveys is changed to Section of Biological Surveys. The bird and mammal collections are now officially designated as the U. S. Biological Surveys collection.

SOME PROJECTS UNDER WAY

The American Society of Mammalogists is fortunate in numbering among its members some of the leading scientists. Some of the personal and official enterprises now receiving attention from various members are as follows:

Revision of North American Recent Mammals, by Dr. Gerrit S. Miller, Jr., United States National Museum.

Revision of Index Generum Mammalium by Dr. Theodore Sherman Palmer, retired, United States Fish and Wildlife Service.

Check-list of the mammals of South America, by Dr. Wilfred H. Osgood, Field Museum of Natural History.

Revision of Trouessart's Catalogus Mammalium tam Viventium quam Fossilium, by Dr. Glover M. Allen, Museum of Comparative Zoology.

Preparation of an Up-to-date list of the Mammal Collections in the United States, by J. Kenneth Doutt, Carnegie Museum.

Preparation of a Textbook on Plant and Animal Ecology by Dr. Walter P. Taylor, United States Fish and Wildlife Service.

A manuscript on the "Extinct and Vanishing Mammals of the World" by Dr. Francis Harper and Dr. Glover M. Allen, Museum of Comparative Zoology.

Preparation of an illustrated key to the Mammals of North America, North of Mexico, by Dr. William B. Davis and Hugo G. Rodeck, Agricultural and Mechanical College of Texas and University of Colorado.

Revision of the Weasels of the World, by Dr. E. Raymond Hall, Museum of Vertebrate Zoology.

It goes without saying that all members of the Society are interested in these projects, and ardently hope that each may be completed and published at an early date. Not only the individual authors but their supporting institutions are to be commended for their part in these enterprises. It would be appreciated if similar projects of special interest to members of the Society could be brought to the attention of all, so that all possible cooperation can be extended by individual members and offices of the Society.